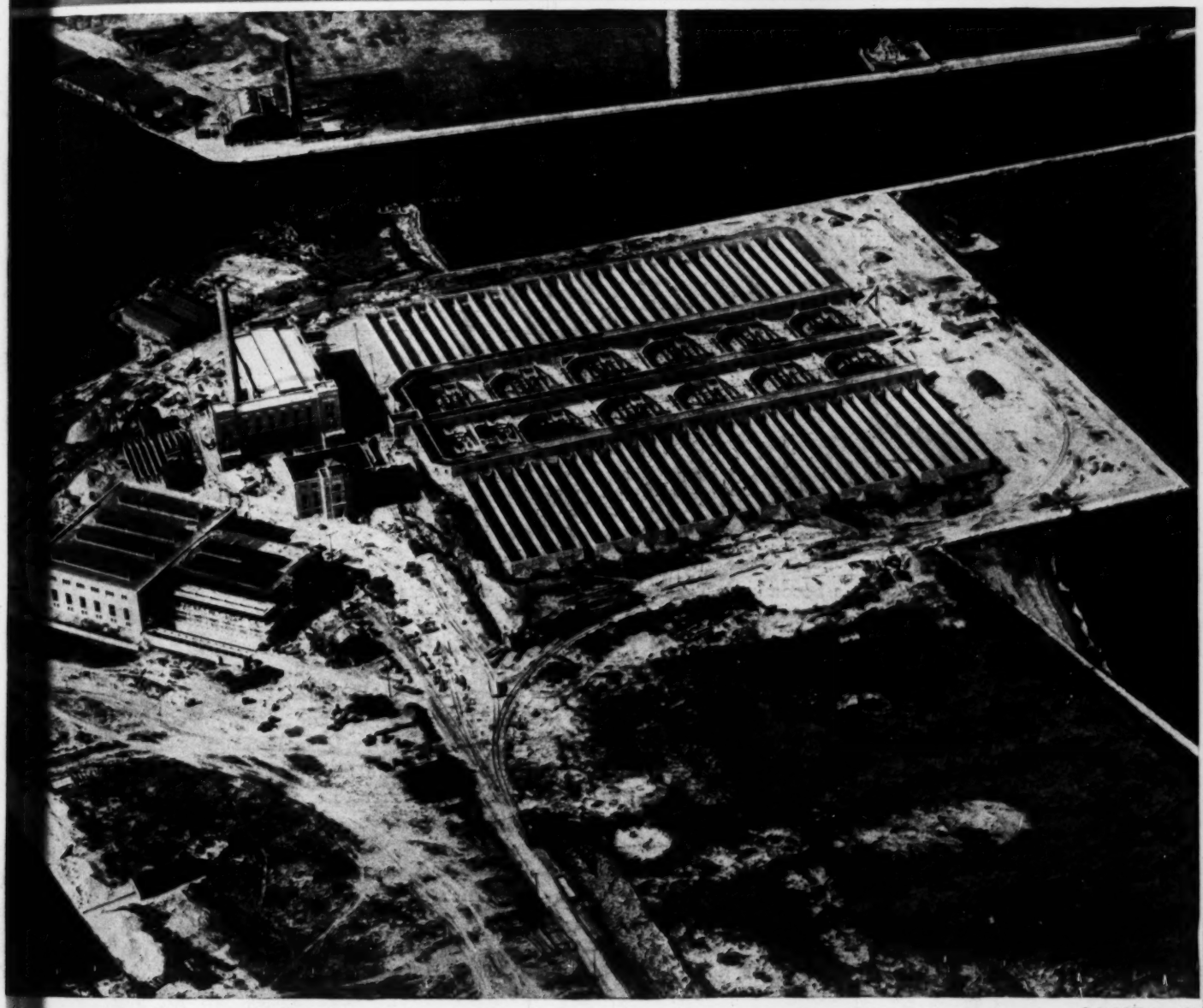
JUL 17 1925

July 9, 1925

Engineering News-Record

Devoted to Civil Engineering and Contracting
McGraw-Hill Company, Inc.



New $8,000,000 Activated Sludge Sewage Disposal Plant at Milwaukee, Wisconsin

© Aerial Photographic Service, Inc.

Modern Road Improvement Practice Sets High Standards—Financing Grade Crossing Elimination—Subaqueous Pile Driving at Portland, Ore. Papers on Concrete Before the American Society for Testing Materials

Lerner Theatre, Elkhart, Indiana
covered with Federal Channel Slabs
K. M. Vitzthum, Architect.

This beautiful theatre is Federal roofed

IT is becoming a general practice with architects to specify Federal Cement Tile for theatre roofs. Because there are types of these tile for every style of flat and pitched roof, and because of the permanent fireproof and safe character of the finished job it becomes more and more apparent as installations multiply that Federal Cement Tile are ideal for roofing theatres and similar types of public buildings. They are light in weight, economical, and come to the job in box cars ready for erection. Federal Cement Tile of precast, steel-reinforced concrete are made, laid and guaranteed by

FEDERAL CEMENT TILE COMPANY
608 S. Dearborn Street - Chicago, Ill.

FEDERAL Cement Tile

"The Roof for Permanence"

ENR7-31-RTG

A Consolidation of Engineering News, Engineering Record and The Contractor

ENGINEERING NEWS-RECORD

McGraw-Hill Company, Inc.
JAMES H. McGRAW, *President*
E. J. MEHREN, *Vice-President*

DEVOTED TO CIVIL ENGINEERING AND CONTRACTING

FRANK C. WIGHT
Editor

Volume 95 NEW YORK, JULY 9, 1925 Number 2

Widespread Destruction

BY CHANCE this issue of *Engineering News-Record* takes on a depressing tone. One unlearned in engineering history who reads only this number may come to the conclusion that engineering structures are most ephemeral and their failure only a matter of fortuitous combination of common events. An earthquake in California, sewer gases in Texas, unprecedented rainfall in Kansas and human and material frailty at Boston—each of these destroyed or partly destroyed the work of man and the manner of that destruction is told in the following pages. But engineers—and we serve engineers—will understand that the diversion of the forces of nature to the use and convenience of man sometimes fails of perfect success and from a study of such failure they can learn how better to design such utilization in the future. We solicit praise, therefore, for our contents this week, though we do deplore the coincidence that brings together so many confessions of defeat between the same covers.

An Important Gesture

WHEN the 300 engineers in the employ of the city of Chicago started a three-day vacation on June 30 as a protest against poor pay they came nearer to striking than any considerable group of professional men had ever been. But they were talking the only language the finance committee of the city council understands. Dignified protests of professional bodies have had no effect on this committee, but it has been consistently open handed with the labor unions. A show of force may penetrate its official consciousness. There will be those engineers who will deplore this assumption of labor union tactics, but they need not worry. The Chicago city engineers are not in a union and their "vacation" has none of the evil connotations of a strike. It was not called by a leader, there was no force used on those who chose to remain at work, it was never intended to continue until the demands were granted. It was a gesture, pure and simple—but experience shows that gestures are frequently effective. Nevertheless it is a significant thing that one group of engineers has at last taken a definite step toward that effective joint and communal action that both labor and management long since took each for itself, to the detriment sometimes of the engineer ground between the nether and the upper millstones.

Licensing Contractors

SHALL we have licensed contractors? This is an imminent question. Last winter the legislature of North Carolina passed a contractors' license law and the licensing board has been appointed and is now functioning. At recent meetings of contractors' associations men of high standing in the business have urged regulation by licensing. At its meeting in Washington this spring the executive board of the Associated General Contractors appointed a committee to ascertain the attiture of its members and to report findings and conclusions. It seems important that contractors should make full response to the committee's inquiries. At present we believe that they have no very firm convictions concerning licensing and indeed no very clear conception of what obligations are involved or of what advantages are promised. They have moreover considerable dubiety concerning the practical gain that engineers have received from their wholesale plunge into license legislation. Behind all else is the prevalent feeling that business is subject already to about all the laws it can easily endure. Altogether in respect to licensing, like the famous citizen from Missouri, contractors are waiting for vision to be given them. It is to be hoped that the answers to the A. G. C. committee questionnaire will be full and based on careful thought.

Wide Roads on Hills

THE 30-ft. concrete highways of northern New Jersey which are described in this issue represent about the highest development in paved country roads. It is to be remembered that these wide pavements are not city streets but rural roads although they are special in the sense that they are confined to hills—grades exceeding 4 per cent—where scour increases shoulder and ditch damage and upkeep. Northern New Jersey is a hilly land so that these 30-ft. pavements are frequent and often are long. We do not think that so much can be said for any other section of the country. Not many states even are building frequently 20-ft. roads, which are the narrowest which New Jersey considers suitable for main traveled routes. There may be question whether any more than extra safety is gained by making the trackway 20 ft. instead of 18 ft., but New Jersey in this portion, as the article points out, is a heavy traveled state and a lower hazard rate for passing vehicles counts up rapidly. How the wide section was developed is told in the article. It is a purely logical outcome of conditions. The testimony is that under these conditions it is a measure of economy. Road engineers generally will be interested in this fact.

Journalism and the Technical Society

NOT long ago we noted in the annual report of a technical society the statement that publication of a news journal had been under discussion by its officers during the year. Other societies have gone through the same stage. It seems to be one of the manifestations of the unfailing human seeking for self expression. The society, like the individual, desires to make tangible record of its activities and aspirations, and bring

them to public knowledge. It is motivated by the ideal of extending its message not merely among its members but farther afield. And this is a noble ideal indeed. But linotype and printing press are hard taskmasters. The lofty aspiration to self expression is often changed beyond recognition amid the ink-stained welter of galley proofs and the flood of printer's bills. Journalism many years ago grew into a profession, working with its special arts and routine, and the amateur who undertakes to dabble in it courts many a disappointment. As a profession, journalism has service to the societies as one of its objects. Yet often we find, as in this case, a desire for publicity remaining apparently unsatisfied. This is a situation that invites reflection. It may be that journalism fails in its service to the technical society, or it may be that the society fails in the nature of its appeal to the journalist. Personally, we hold to the latter view. But, whichever be true, the public, the reader, is the ultimate loser.

Road Detour News

A VALUABLE travelers service developed in the last few years by state highway departments, is the regular publication of road closures for new construction or maintenance. Practice differs but universally it has progressed beyond the original local posting of a bulletin of detours, to a general announcement weekly of all operations of construction and maintenance which make the re-routing of travel necessary or desirable anywhere in the state. An example is the poster map and typed news bulletin issued weekly by the Pennsylvania department of highways. Pennsylvania practice is not quoted because it is more nearly perfect than that of all other states but because it is an example of the perfection of service developed by leading road building states. The Pennsylvania bulletin covers the week in advance of the date of publication. It is a poster sheet showing detours printed and numbered in red on a state road map. The map numbers refer to a detour schedule printed below and giving the location, the length and the road conditions of the detours. The typed news sheet announces the new detours opened, the old detours removed, and the road oiling schedule for the week ahead. Taking a publication of such detail and frequently, with careful detour-sign posting in the field and special maintenance of the detour road and the detour annoyance which new road construction always involves is reduced to about its least practicable dimensions.

Earthquake Effects at Santa Barbara

REPEATING on a small scale the structural experiences of the Tokyo earthquake of two years ago, the Santa Barbara shocks whose effects are reported by H. D. Dewell strengthen the conclusions drawn from that disaster and re-emphasize the need for taking them into practical account in construction. Ordinary wall-and-joist construction fared badly, while buildings having integral structural frames suffered little damage, when well built. Individual happenings such as the striking case of the destruction of part of the San Marcos Building make it clear that the presence of a structural frame will not in itself give safety, but that the frame must be of sufficient strength. Detail failures in other buildings, which as a whole stood up and gave protection to their occupants, show that design must be carried out with specific regard for earthquake forces; we cannot expect that a building planned and built with sole regard to loads and wind will of itself possess the necessary earthquake resistance. Thus the Santa Barbara report brings earthquake-resisting construction to the front of the structural stage, as a commanding necessity for regions known to be subject to seismic disturbances.

Following the Tokyo disaster, there was long-continued discussion as to the precise factor of lateral acceleration to be used in designing a structure for resistance to earthquakes. Factors of one-tenth and even one-fifth or more of gravity were recommended, we believe. But it would seem that the particular factor used is of less importance than that some one factor be recognized as controlling throughout the entire design of a structure, and that the structure be so proportioned and built as to give in all of its parts an effective resistance corresponding thereto. In addition—and this is perhaps even more important—the parts of the structure must be thoroughly integrated; the structure must have coherence, in order to be proof against having its walls shaken out, its roof framing and cornices catapulted off, or its separate footings shifted and disarranged. Provided the requirement of coherence—structural integrity—be scrupulously met, as by bonding, tying, bracing by cross-walls and the like, the proportioning of major structural parts for the lateral forces that will come into play during the earthquake should not present insuperable difficulties.

Again with main emphasis on the controlling importance of structural coherence, it may well be that ordinary construction, wall-and-joist construction, can be made so greatly superior to the deplorably weak condition revealed by the Santa Barbara experiences as to give a fair degree of protection in all but the most violent seismic shocks. A glance at a picture of the Californian Hotel reveals remarkable possibilities in the way of combined resistance and adjustment that inhere in even such light stud-and-joist construction; and had not the long, unbraced walls of this structure been devoid of cross-walls and innocent of joist-anchoring to a degree that made it inevitable that the loosely-associated parts should shake to pieces, the building might quite possibly be standing today superior to its reinforced-concrete neighbor, the San Marcos Building. So also the Arlington Hotel would present a different picture if the masonry of its walls, however economically planned, had been tied together and bonded to the frame firmly enough to hold its own mass together in the shaking.

No evidence appears in Mr. Dewell's report, or in any of the other news that has come from Santa Barbara, to indicate that building construction there contained any allowance for earthquake action. Considering this fact, and the great amount of poor construction present in the wrecked buildings, it is rather reassuring that the city survived so well—that all of it was not impartially thrown to the ground. It is reassuring also to learn that a great deal of the destruction is chargeable directly to serious defects of design and construction, and that good construction resisted well in spite of lacking separate provision for earthquake forces.

But these conditions only lay the more stress on the plain showing of the disaster, that buildings in earthquake regions must be designed for earthquake action.

Of the possible application of the same principle to other localities—those not recognized as seismic—we may have something to say later. For the present it can be set down as a clearly demonstrated truth that the earthquake hazard, where it is known or may fairly be presumed to exist, is too serious a threat to community existence to warrant continuing the light-hearted practice of ignoring the requirements of earthquake-resistance in public building construction. The teachings of recent earthquake destruction may yet have to be studied and greatly developed in practical application, but they already constitute the elements of a science to provide the foundation for a practical art whereby the dangers of seismic disaster can be greatly reduced.

Commendable Curiosity

FOR a considerable time engineers have gone along with the theory that cement is cement, that concrete is concrete whatever its exposure and its use, and that provided the cement passes certain uniform standard specifications, its obligations are ended. The making of concrete is a delicate operation, which has many components and any one of them may affect the final result. Cement is only one of the elements and there are many reasons to believe that the ordinary cement of commerce will in all but a few instances make an adequate concrete provided the other elements are properly looked after. There is a tendency, therefore, to discourage such examinations as A. T. Goldbeck made in his A. S. T. M. paper abstracted on p. 64, to say why worry about the cement when there are so many things that need greater worrying over; let's teach our workmen and educate our foremen and reason with our contractors and our engineers until they, who taken together, are making the poor concrete, begin to practice what a few enlightened students of concrete are preaching. Then when we have cured some of these obvious diseases can we commence to look into the cement.

But Mr. Goldbeck has discounted this kind of criticism by admitting the facts that lead up to it, but admitting those facts he very wisely points out that there are some things we do not know about cement and that there are some things we would like to have in cement for the special purpose with which he is concerned. This is a desirable kind of inquisitive thinking that provokes study which in turn will bring about worth while results.

Cannot such scientific curiosity be profitably extended into the whole field of the cement specification, rather than to confine it merely to those properties peculiar to highway concrete? We are having brought to our attention more and more the unreliability of cement testing. Certain investigations made by government bureaus, and unfortunately withheld so far from publication, show that for samples of the same cement, carefully selected, packed and shipped so as to insure identity of product, equally competent laboratories produce widely varying results under the standard specification for testing. The same laboratory, or a group of laboratories under the same direction can sometimes get concordant tests, but who knows which of the methods is the right one, when different experts interpret standard test methods differently. Shall we discard as unusable a cement which one laboratory will certify to pass a specification and another will reject or are we to begin to question whether possibly our so-called tests really indicate what they are supposed to indicate?

Committee C-1, of the American Society for Testing Materials, the sponsor of the standard cement specification, meets this criticism this year by preparing a manual of testing which particularizes the technique of cement testing in far greater minuteness than has been done before. By conscientious following of this manual doubtless many of the vagaries of cement test results will be removed. But will they all be? That is a fair question and it is a question bound up to the more involved one of whether the tests are real indications of the things we need to know about cement.

Is fineness something that it is worth while to know about? What relation is there between the behavior of the soundness test pat and the behavior of a concrete made from that cement? Do tension briquettes really indicate anything we want to know? Such questions are worth asking, before we get so buried in the details of testing that we forget that after all we do not care very much about the personality of the cement itself. What we want to know is how that personality affects concrete. Cement is not in itself a structural material, it is not load bearing, it does not have to resist wear or weather or impact. A small piece of steel is a fair simulacrum of the steel member which is an engineering entity but a batch of cement is only the beginnings of a concrete structure. And yet in considering cement there is the tendency common to all testing to become so absorbed in the technique of the test as to forget what that test is for.

One thing is certain. If adherence to a standard manual of testing does not produce more concordant results for cement than studies of different laboratory results of the same cement are bringing to light, the cement test and the cement specification, too, might just as well be abandoned, for engineers who purchase under it are living in a false security. If a cement is rejected or accepted merely by the different operation of laboratory technique it is obvious that such testing is ridiculous. Or if the best development of that technique cannot assure concordance it is time to investigate more thoroughly the material itself.

There was a time when such a suggestion would have been construed as an attack on cement, but that time is happily past. The enormous and growing production of cement is testimony in itself of its secure standing today. Suggestions for improvement are therefore now a friendly act and are so interpreted by those who make cement, for they realize better than any one else that their product is not perfect and the more uniformly it approaches perfection the more of it will be used.

The time has come in cement technology when curiosity is a sign of progress. The investigation now under way at Washington by the Bureau of Standards and the Portland Cement Association is one of these signs. Such a paper as that of Mr. Goldbeck shows that others are beginning to be assailed with that scientific doubt that is the beginning of knowledge. These doubts might well go back to the beginning and be directed toward the standard specification itself and the methods of determining whether that specification is fulfilled. Cement and the concrete made from it are great materials but who that uses them doubts that they can be made better.

Modern Road Improvement Practice Sets High Standards

Northern New Jersey Examples Bring Out Strikingly the Attention Given to Relocation, Widening and Heavy Construction on Highways in Territory Having Large Volume of Traffic

By L. E. Andrews
Division Construction Engineer, Northern Division, New Jersey State Highway Commission, Newark, N. J.

TRAFFIC conditions have set high requirements for road improvement in northern New Jersey. This part of the state, lying between the metropolitan districts of New York and Philadelphia, is traversed by the traffic movement between and tributary to those cities. This movement calls for road improvement in proportion to its magnitude. Again this part of the state is the location of seashore and mountain resorts of country-wide popularity and this resort pleasure traffic movement again calls for high road standards. It is here attempted to indicate by example how road improvement practice has been worked out to fit the situation.

First, let it be observed that the standards presented by the northern New Jersey examples are essentially the standards of all the states where similar conditions are their warrant. It is a state practice in high-class road building that is considered and not sectional practice, although sectional examples exclusively are presented. Incidentally the road construction divisions are three: Northern, Central and Southern. Each is in charge of a division construction engineer under the direction of the state construction engineer and the state highway engineer.

Design and Type—Reinforced concrete is the standard construction. There are two designs as shown by Fig. 1. For all grades under 4 per cent the pavement slab is 8 in. thick and 20 ft. wide. Generally it is possible to keep all grades under 7 per cent. The maximum curvature is generally held at 6 deg. but there are some cases where this figure must be exceeded. Generally, on grades of 4 per cent and over, a 30-ft. paved width with curbing is provided. This design has proved economical as drainage is adequately taken care of and the maintenance of shoulders, which is always costly on heavy grades, is eliminated. The added element of safety can also be appreciated.

The development of the use of this wide section has been gradual. Originally the main paved width on heavy grades was widened on each side with 5-ft. grouted rubble gutters. This type of gutter was later changed to plain concrete as it was found that there was little difference in cost. There being no curb, the gutter was dished in order to be most effective. It was later felt that this gutter width might also be made useful for traffic by having it conform to the crown of the rest of the pavement and by constructing curbing properly to take care of drainage. Thus the 30-ft. paved width is now in general use, drainage is adequately provided for, shoulder maintenance is eliminated and an added safeguard to traffic on steep grades is obtained. Examples are shown by several of the illustrations.

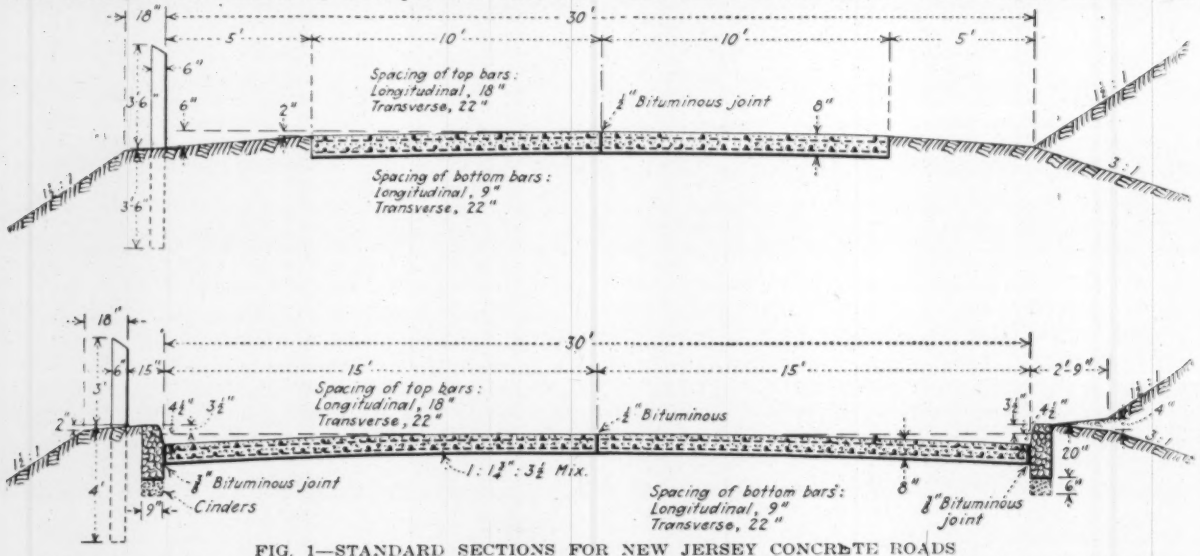


FIG. 1—STANDARD SECTIONS FOR NEW JERSEY CONCRETE ROADS
The 20-ft. pavement is used on all grades including 4 per cent and for steeper grades the 30-ft. section is used. Both pavements have a center joint and are heavily reinforced.

In both widths double-line bar reinforcing is generally used, particularly in the northern part of the state where subgrade conditions are least uniform. Deformed bars ¾ in. in diameter are most widely used. The main members are spaced 9 in. c. to c. longitudinally and the secondary members 22 in. c. to c. transversely. Where double mats are used, they are separated by a 4-in. space and held rigidly apart by steel separators. The longitudinal bars of the upper mat are spaced 24 in. c. to c. Main members are parallel with the axis of the pavement. The fabricated mats are installed in the pavement at the proper location by spreading a 2-in. layer of concrete on which the mats are placed and concreting at once to finished grade.

Gravel or crushed stone concrete is used, a good

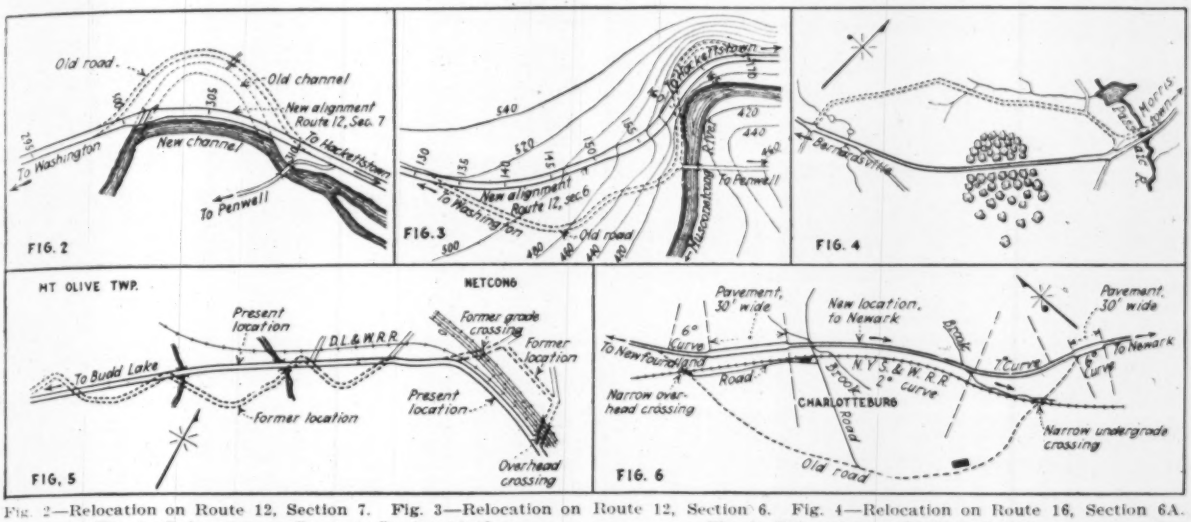


Fig. 2—Relocation on Route 12, Section 7. Fig. 3—Relocation on Route 12, Section 6. Fig. 4—Relocation on Route 16, Section 6A. Fig. 5—Relocation on Route 5, Section 13-12. Fig. 6—Relocation on Route 8, Section 4A

FIGS. 2-6—RELOCATIONS ON ROADS IN NORTHERN NEW JERSEY—SOME REQUIRING RIVER DIVERSIONS

quality of both aggregates being generally available. The proportions are 1:1¾:3½. The pavement is constructed one-half at a time while the opposite side is kept open for local traffic and the contractor's operations. A ½-in. longitudinal center joint is provided using either poured or premolded filler. Transverse joints using the same type of filler are placed from 34 ft. to 56 ft. apart. In order that an even and uniform surface finish may be obtained, it is provided that a heavy screed board or planer weighing not less than 20 lb. per lineal foot be used after the initial striking and tamping. After belting, the final finish consists in brooming transversely with ordinary street brooms.

Relocation Practice—A significant part of the improvement practice is relocation of old roads to improve line and grade and to reduce distances. A number of such relocations are shown by Figs. 2 to 6; all were operations carried on in 1924.

Particular attention is called to Fig. 2 showing the relation of the highway and the Musconetcong River on Route 12, Section 7, between Washington and Hackettstown. The principal reason for this change was the reduction in curvature from 22 to 6 deg. It was necessary to shift a 1,000-ft. section of the river laterally for a distance of 300 ft. The first operation consisted in excavating the new channel 60 ft. in width. The excavated material was used in the new highway embankment adjoining. After the new fill was completed and riprapped on the river side, the upstream end of the new channel was blown through, thus diverting the stream. Fig. 12 is a view of this relocation.

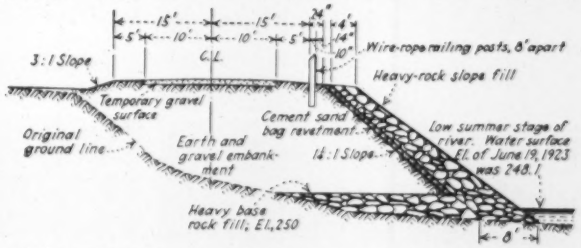


FIG. 8—CEMENT BAG SLOPE PAVING UNDER RIPRAP

FIG. 7—SLOPE PAVING ON EMBANKMENT BORDERING RIVER

Fig. 3 shows change in alignment on Route 12, Section 6, between Washington and Hackettstown. By this change the maximum curvature was reduced from 25 to 8 deg., the maximum grade of 7 per cent was considerably shortened and a saving in distance of over 600 ft. was obtained. Fig. 11 is a view of the change at this change of line.

Figs. 4 and 5 show other extensive relocations as constructed last season which involved practically the entire lengths of Route 5, Section 13, between Budd Lake and Netcong, and Route 16, Section 6-A, between Bernardsville and Morristown. On Route 5, Section 13, the total number of curves was reduced from 12 to 4 and maximum curvature was reduced from 20 to 5 deg. Fig. 6 indicates how two bad railroad crossings were eliminated and a considerable saving in distance effected on Route 8, Section 4-A, near Charlotteburg, by relocating the highway.

Such changes as above outlined have been common to all projects in recent years. In most cases considerable savings in costs have resulted by such relocations;

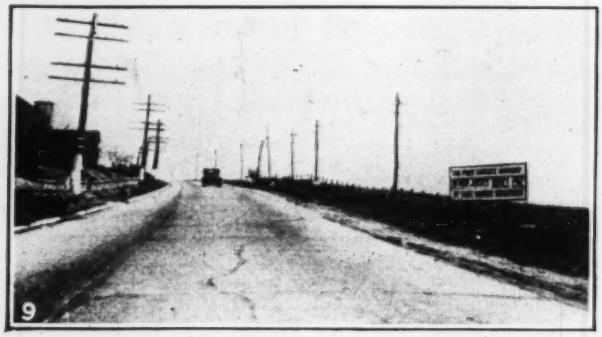


Fig. 9—First concrete road built in New Jersey in 1912 between Washington and Phillipsburg, still in good service.

Fig. 13—Typical 30-ft. pavement with curbs on grade near east end of road relocation shown by Fig. 4.

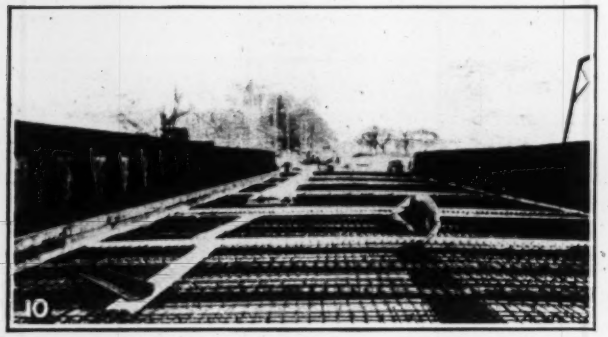


Fig. 10—This is typical of bridge construction practice—a concrete encased steel girder through structure.

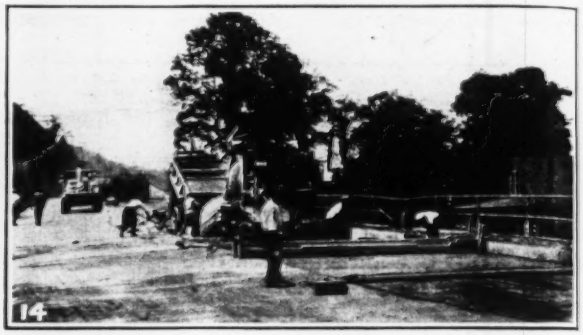


Fig. 14—Method of constructing pavement in two strips. Street broom lying on pavement used to obtain final finish.

Fig. 11—Relocation shown by the sketch plan in Fig. 3. New road in center and old road at right and left; grade 7 per cent, curves 6 to 8 deg.

Fig. 15—Hairpin curve in the middle of the descent from the top of the Palisades to Fort Lee ferry; pavement 26 ft. wide.

Fig. 12—Relocation shown by the sketch plan in Fig. 2—Musconetcong River diverted and highway strengthened and shortened; curvature reduced from 22 deg. to 6 deg.

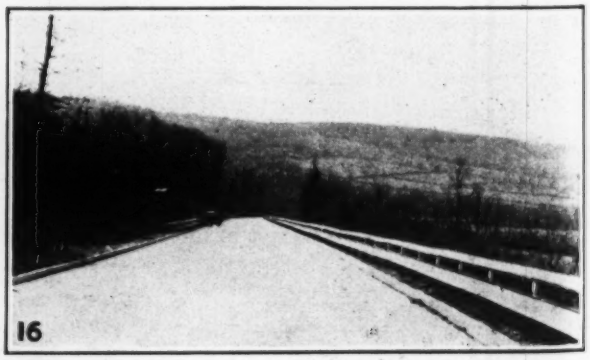


Fig. 16—Showing 30-ft. pavement with curbing crossing Schooleys Mountain; grade on west side is 2 miles long and averages 6 per cent.

FIGS. 9-16—CONCRETE ROAD CONSTRUCTION AND RELOCATION AND BRIDGE CONSTRUCTION PRACTICE IN NORTHERN NEW JERSEY

however, cost has not stood in the way of necessary improvements where safety of traffic was at stake. While the greater number of relocations are short in distance, there have been many several miles in length. This is particularly true of the so-called gateway approaches to the Holland Tunnel between Elizabeth and Jersey City and the Delaware River bridge in the vicinity of Camden. A new highway has also just been located along the top edge of the Palisades in the vicinity of the New Jersey-New York state line. This highway will be situated some 400 ft. above the Hudson and will develop the wonderful scenery of the region which is in sight of New York City.

In the cases where river relocations have been necessary as a result of highway changes, special methods of river protection of new embankments have been developed. Notable among these was the revetment constructed along a section of Route 5, Section 11, at Manunka Chunk last season. The new embankment constructed in the river at this point is about 25 ft. in height. The outer slope is protected by a sand-cement bag paving laid on the natural slope of the gravel fill. After this had thoroughly hardened a heavy rock fill was placed over it. The width of this rock facing is 8 ft. at the bottom and 4 ft. at the top. Views of this work are shown in the accompanying illustrations. High water and an ice gorge failed to damage this construction during the past winter. A plan and a view of the revetment are given by Figs. 7 and 8.

The major part of highway construction in New Jersey is being financed from a $40,000,000 bond issue which was authorized in the fall of 1922. This sum is being made available in installments spread over a period of five years.

The work here described is under the New Jersey State Highway Commission; W. G. Sloan is state highway engineer and C. F. Bedwell is construction engineer.

Tests of Theater Curtains Indicate Safety Requirements

SEVERAL types of theater curtain were recently tested for fire-resistance and strength at the U. S. Bureau of Standards. They included both rigid-frame and non-rigid curtains, some with single and some with double covering. The non-rigid curtains proved inferior in both fire resistance and strength to those of rigid type, and in several instances also allowed smoke to pass around the edges and developed excessive friction against their guides when under even slight wind pressures. Certain conclusions drawn from the tests as to requirements of safety in theater curtains are noted below.

Two rigid curtains included in the tests had I-shaped built-up steel frames, in one case riveted and in the other case welded, respectively 7¼ in. and 5½ in. deep, covered on the stage side with ¾-in. asbestos board and on the auditorium side with a steel sheet. The sizes of the panels included in the tests were 16x11 ft. in the first case and 9x6 ft. in the second case; the spacing of the cross-members of the frame was generally not over 3 ft. These curtains, when subjected to fire of 1,800 to 1,950 deg. F. on the stage side for 30 min., showed temperatures on the other side at the end of the test of 400 to 500 deg. F. Both gave satisfactory performance as to protection against fire. Neither showed surface glow from the heating and only a slight smoking developed on the oil paint on the steel toward the end of the half-hour test. The indications were that both would afford protection to life and property for a somewhat longer time.

Two unstiffened asbestos cloth curtains developed considerably lower heat-resistance and transmitted higher temperatures. They were tested in sizes of 16x12 ft., with 15-min. exposure to temperatures of 1,400 to 1,600 deg. F., with the result of developing temperatures of 750 and 1,000 deg. F. on the auditorium side at the end of the 15 min. The first of these was a double curtain of plain (unreinforced) asbestos cloth on pipe battens top and bottom, the sides being fitted with rings sliding on ¾-in. standing cables. The other was a single thickness of asbestos cloth similarly mounted on pipe battens with cable side guides, the cloth, however, weighing 4.9 lb. per square yard, or almost twice as much as the cloth used on the other curtain, and containing a monel metal wire reinforcement in the yarn.

Somewhat better results than those of the non-rigid asbestos curtains were obtained from a semi-rigid and a rigid-frame asbestos curtain, the former being held along the sides by a number of four-wheel trolleys running in a closed metal track, which in part served as guide anchorage to the curtain. These two curtains gave encouraging results and it is stated that "with few modifications they would give the required protection to audiences."

From a report of the tests given by Nolan D. Mitchell, structural engineer of the U. S. Bureau of Standards, in the *Quarterly* of the National Fire Protection Association for April (p. 366), the following suggestions and requirements with respect to safe theater curtains are taken:

A double curtain with an air space between the two plies gives better protection against smoking and blowing than a single curtain. To avoid strong smoking, decorative paint should contain little or no organic matter. Cross-members should not be spaced farther apart than 8 ft., to give support to the asbestos cloth. Top and bottom battens should be connected by rigid members so that the curtain will descend as a unit and make its entire unbalanced weight effective in dropping the curtain. To assure good lowering, rigid side guides with anti-friction hangers or trolleys, or smooth metal slideways at guides and top of the proscenium opening, should be used. The unbalanced weight of the curtain should be sufficient to bring the curtain down even under a side pressure of 5 lb. per square foot, with a friction factor of unity. Closure should be by gravity. Emergency closure controls capable of being operated by hand from two or three points and also automatically by heat-operated devices should be provided. These controls should be interconnected with the emergency venting devices. The strength of the curtain and its mounting should be sufficient to withstand a lateral pressure of 10 lb. per square foot on the entire curtain, with a factor of safety of 2 on the ultimate strength. To provide a reasonable time for safe exit of the audience, the curtain should afford protection for at least 15 minutes. Well constructed double asbestos cloth curtains such as the better types tested will meet this requirement and afford considerable protection to the building. Rigid steel curtains of the two types tested will afford protection for one-half hour or longer and will give greater protection to the building.

Chicago Engineers Define Scope of "Free" Engineering

Concurrence by Architects Secured—No Rules but Co-operation Requested to Eliminate Unethical Practice

AFTER discussing the question of "free' engineering services in committee for several months the Board of Direction of the Western Society of Engineers has approved the report and conclusions which have been concurred in by the Chicago Chapter of the American Institute of Architects and the Illinois Society of Architects. No rules or regulations are recommended but all concerned are asked to co-operate to eliminate objectionable practices. The place of design by the manufacturers' engineering staff is defined and definition is given of bad ethics on the part of an engineer or architect in turning over manufacturers' designs as his own.

The matter was brought up because complaints were made to the officers of the society relating to certain practices by engineers, architects, contractors and manufacturers, under which it was claimed that injustice had been done to professional engineers and the public. The complaints alleged that certain engineering services are rendered without specific remuneration.

A consulting engineer complained of an agent who sells chemicals offering to furnish plans for a water purification plant. Design of reinforced-concrete construction without specific remuneration by certain merchants selling bars was objected to. A structural engineer complained that certain contractors offered to build bridges upon their own designs without pay for engineering services and similarly a contractor complained against certain building contractors offering to build from their own plans without specific pay for architectural services. A mechanical engineer objected to a manufacturer installing heating equipment under his own plans without specific pay for the engineering involved. An architect objected to a manufacturer of jail equipment and vault equipment offering to make plans and specifications for the building, providing the manufacturer's equipment is purchased. A mechanical engineer complained that contractors for piping a building offered to make plans free on the prospect of being awarded the contract.

In the recital of the development of engineering specialties the committee report states as follows:

The steam pump was first largely used in this country, in water-works systems, about forty years ago. The first machines for this purpose were conceived, designed, built and installed by manufacturers who found it necessary also to design and build the pipe systems and appurtenant works necessary for the utilization of the pumps as there were no engineers in general practice familiar with the subject. Thus the practicability of steam pumps in general systems of municipal water-works was demonstrated. In the course of time many technical men became expert in the application of pumping equipment, and the designing of the appurtenances necessary for water supply. As knowledge of this subject became more general the manufacturer found plenty to do in the manufacture of his pumps and various other devices in the projects gravitated to certain other manufacturers. At the present time practically all the designs are made by consulting engineers, or by engineers and operating officers in the employ of municipalities and corporations, and the larger part of such equipment is purchased on plans and specifications.

The mechanical filter for the purification of water is an American invention, conceived, designed and demonstrated by an American manufacturer. When first placed upon the market its efficiency was discredited by sanitarians in general. The early installations were designed and built by the manufacturers who sub-contracted the necessarily appurtenant miscellaneous structures. In order to get business the manufacturer necessarily guaranteed the efficiency of the process to produce clear, pure water. In the course of time, ten to fifteen years, the value of the mechanical filter became generally recognized. Other manufacturers entered the field. Several bids on widely different bases were presented for each job. For a few years detailed designs were made by manufacturers under general specifications prepared by engineers for purchasers. As the process became generally known to engineers the art finally reached the stage where detailed designs were made by purchaser's agents, the greater part of the construction was carried out by general building contractors and the work of the filter companies was limited to their special apparatus in the same way that the equipment of buildings is now generally sold. Mechanical filtration, now serving water to 20,000,000 people in the United States, saving thousands of lives annually, could have been developed in no other way.

Reinforced concrete in the past thirty years has gone through much the same process and development. At first only a very few knew how to design it. Builders were skeptical of it. Early structures were designed and built, by those who conceived them, under some form of a guarantee. At present, knowledge as to design is widely disseminated among technical men. There remains some effort on the part of steel merchants to assist in the design as an extra inducement to the purchaser. This tendency is rapidly disappearing. The evils resulting from the practice will be self-curative with a wider distribution of knowledge.

Structural steel has had a similar history. Certain large contractors secure many large undertakings under a form of contract, in which design and construction are furnished. Such a contract, including both professional and commercial service, eliminates competition in construction and must be executed with the most scrupulous care to protect the interests of the owner. The form of the remuneration varies somewhat.

A contract is unfair, and not in the interest of the public, where a builder, or others, prepares a design and subsequently becomes a bidder in competition with other contractors under his own design. This practice should be discouraged. Under any circumstances, success in carrying out work in which the constructor designs, depends upon the ability and integrity of the contractor. Such work should be carried out under a form of contract, through which the contractor has every incentive to do good work with a proper regard for economy.

The full wording of the conclusions is as follows:

(1) Engineers, architects, manufacturers and contractors should co-operate, in so far as possible, to eliminate objectionable practices, whereby unfair advantage is obtained on the part of one at the expense of the other, or where the buyer may be imposed upon.

It is perfectly evident that there is no such thing as free engineering. There must be a sufficient remuneration. It is in the interest of all that this remuneration should be fair and open. An exorbitant remuneration should not be concealed in the price of the article or device.

(2) It is recognized that new contributions to advancement in the useful arts must pass through a stage in which the designer builds and takes full responsibility. If the contribution is a real advancement, knowledge regarding it ultimately will be widely disseminated, after which it will be designed by purchaser's agents.

With a widely expanding field this is accepted as inevitable by the manufacturer. In many cases it is welcome. This condition comes about through evolution, it cannot be influenced to any large extent by rules and regulations on the part of practitioners.

(3) The business of manufacture and sale of machinery and complicated equipment cannot be conducted today without an engineering force, expert in the application of the equipment. No consulting engineer or architect should fail to advise himself regarding available equipment by

consultation with the manufacturer's experts. There is no other way to apply correctly the best devices to the required service. However, no self-respecting engineer or architect will secure from a manufacturer the design of a structure, or a part of it, under an implication that a purchase will be made from the manufacturer and then turn over to the client the result of this work as his own. This is bad ethics and bad morals.

(4) This committee recommends no legislation and no rules on this subject. It is suggested that this report, or such part of it as may seem useful, be published in the *Journal* of the society.

H. J. Burt was chairman of the committee and C. B. Purdick, W. J. Lynch, Linn White, R. G. Rosenbach, V. A. Matteson and J. T. Hanley were the other members.

Subaqueous Pile Driving at Portland, Ore

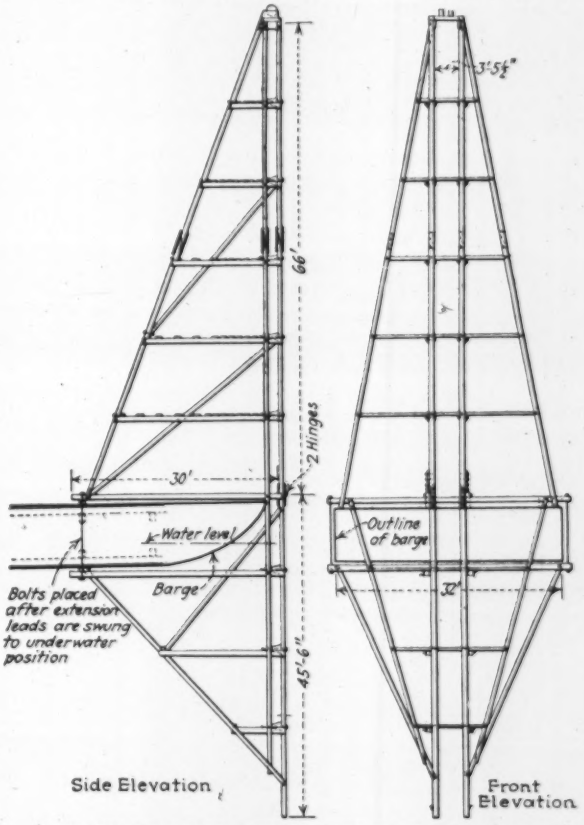
Compressed Air Used in Operation of 7½-ton Hammer 65 Ft. Below Surface—Leads Hinged and Braced to Under Side of Scow

CONSTRUCTION of the Burnside bridge across the Willamette River at Portland, Ore., called for the placing of pile foundations for four concrete piers. These piles had to be cut off 10 ft. above the river bottom or about 65 ft. below the surface of the water. A subaqueous hammer was chosen for driving the piles because it made possible the use of 50-ft. instead of 120-ft. piles. As exact location of each pile was desired, an underwater section of stationary driver leads was fastened to the under side of the driver scow and the drop leads were thus as accurately held in place and guided below water level as they were above.

Excavation at the site of each pier was made with a clamshell before piledriving began and the 10-ft. projection above the bottom of this excavation allowed this much of the piles to extend into the concrete base of the pier which was later poured by the open caisson method around the tops of the piles. The original plan called for piles with a minimum tip diameter of 12 in. to be placed on 3-ft. centers and to have a penetration below the bottom of the concrete of 40 ft. These requirements were modified, however, when it was found that it was not practicable to use a jet in sinking the piles because there was enough gravel in the ground to sink to the bottom of the jetted hole early in the operation of the jet, rendering its further use ineffective. On the other hand, piles of this size could not be driven on 3-ft. centers without either removing some material by jets or decreasing the 40-ft. penetration requirement. Accordingly the pile spacing was increased to about 3½ ft. and an average penetration of about 30 ft. below the bottom of the excavation was accepted as satisfactory. Under these conditions there was no noticeable upheaval of the excavation bottom due to piledriving.

Aside from the saving in extra cost for very long piles, it was believed that the subaqueous hammer would give much better results, in the hard driving anticipated, than could have been expected if long piles or a long follower was used. This belief was based on the fact that the subaqueous hammer would deliver the entire force of the blow directly to the piles which were put down in the 40-ft. lengths required plus a slight additional length that would make it possible to cut them all off to the same level. A 13,100-lb. hammer was used.

It was thought that the condensation of steam in the 50 ft. or more of underwater steam hose would affect the operation of the hammer, and it was decided to operate it by compressed air instead of steam. A steam-driven air compressor was therefore installed on the driver barge. It was estimated that the hammer would require 600 cu.ft. of free air per minute at a pressure of 130 lb. per sq.in., plus a small quantity of



ARRANGEMENT OF HINGED UNDERWATER LEADS

air at pressures varying from atmosphere to 25 lb. to be used in keeping water out of the working chamber. However, an air compressor of considerably greater capacity and equipped with large flywheels was selected. With this large-capacity machine working considerably below capacity rating there was a notable absence of vibration on the barge. The large flywheels are reported to have proved their worth in effectively reducing the amount of steam required.

Three lines of air hose were carried to the hammer: a 2-in. line for the main air supply, a 2½-in. line to carry the exhaust above the water surface and 1¼-in. line to carry the low-pressure air to the working chamber of the hammer to exclude water from the chamber so that the hammer would work in air as under normal conditions. The pressure on this latter line was kept at about ½ lb. for each foot of depth in order to offset the increase in hydrostatic pressure. It was found that too great a pressure interfered with the working of the hammer and that too little let water enter the jacket and resulted in injury to the hammer.

The driver scow was equipped with ordinary stationary leads 66 ft. high and in these were slung drop leads 61 ft. long. This arrangement permitted leads and hammer to be hoisted above the water which brought

the pile up so it could be dogged at the foot of the leads with three ½x2½-in. iron straps hinged to the lowest yoke so that the pile point would be held in exact position while it was being lowered to the bottom. These straps were fastened to the pile point with 60*d* spikes which would pull out when the hammer started driving, thus freeing the pile from the straps.

As the accuracy of the pile spacing depended on spotting the driver in exact position and keeping the leads vertical, an underwater section of stationary leads was provided below the bottom of the barge, and these served as a rigid guide for the drop leads, extending the function of the ordinary leads of the barge to a point 40 ft. below the water surface. For ease in installing the underwater leads and to permit them to be raised for repairs or to pass shallow water, they were attached by hinges to the bottom of the regular leads. Around this point as a center they were swung into place below the barge, and then fastened in position by bolts clearing the sides of the barge and passing to the upper framework of the driver.

The driver barge was 32x100 ft. in plan and 8 ft. in depth. Steam boiler, compressor, hoist and other equipment were mounted on the rear end, the leads being mounted at the front. The hoist selected for this use was equipped with four drums which made it possible to use a separate line for hammer, drop leads, pile and jet. With this equipment the normal operation was about 15 piles per 8-hr. shift. The cost of operating this rig is stated to tally very closely with the operating cost of the ordinary driver working above the surface.

The use of the subaqueous driver with the attendant accurate placing of piles, coupled with the fact that this method could be used when there was considerable current in the river, made it possible to drive the piles while the timber cribs were in process of construction and thus the cribs could be placed over the piles and the concrete seal poured as soon as they were in place. This was considered a great advantage in view of the short season during which the work could be carried on.

The contract for this work is held by the Pacific Bridge Co.; Philip Hart of that company devised the method of handling the work described in the foregoing. H. Rode is resident engineer for Gustav Lindenthal of New York, consulting engineer for the county on the present bridge work.

Highway Board Proceedings Summarized

The Highway Research Board of the National Research Council has issued a 24-p. pamphlet covering the development of the board, its aims, organization and membership, and summaries of the reports of all committees read at the third and fourth annual meetings. Each summary occupies one self-contained page, making it possible for a busy reader to take in almost at a glance the entire proceedings of two years of highway research. It is pointed out by Charles M. Upham, chief engineer of the North Carolina State Highway Department and director of the Highway Research Board, that the volume has been issued for the purpose of satisfying a widespread demand for condenser and accurate data on highway research. He points out the fact that papers read at the meetings which any particular person may want to peruse in detail are available in the proceedings of the board. Requests for such papers may be made to the Highway Research Board, National Research Council, Washington, D. C.

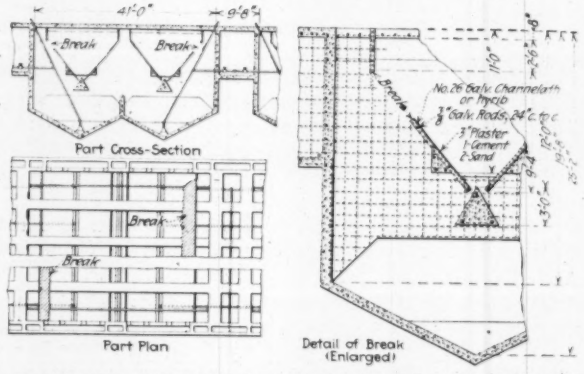
Accident to Imhoff Tank Unit at Fort Worth, Texas

Breaks in Sloping Bottoms of Settling Compartment Attributed to Gas Pressure in Vents, With Possible Water Hammer

BY JOHN B. HAWLEY
Consulting Engineer, Fort Worth, Tex.

PARTS of the partition walls of one of the Imhoff tanks at the sewage-works of Fort Worth, Texas, were wrecked about March 1 by some sort of explosion (or perhaps water hammer), as shown by the accompanying illustrations. The breaks were 56 ft. in length on one side and 32 ft. on the opposite side of the unit and appeared also at opposite ends. Construction of the tank was completed about Jan. 1, 1924, and the tank was placed in use about April 25, following.

For some time prior to this accident considerable quantities of "bottom settlings" from oil tank farms or elsewhere in and near Fort Worth found their way into



PLAN AND SECTIONS OF FORT WORTH IMHOFF TANK WHERE BREAKS TOOK PLACE

our sewerage system and began showing up in the Imhoff tanks. This petrolic material seemed to enter the disposal plant in emulsified form, but segregated into real sheets of oil in the tanks, and saturated the "scum" or "foam-felt" in the gas vents. The scum in the gas vents was allowed to accumulate to considerable thickness, estimated by the operator to be at least 2½ ft. (although it may have been much greater). Examination of "scum" material after the accident showed it to be quite dense, probably "gastight," and its surface had risen well above the top of gas vent walls. After one day's drying in air it would readily burn to ashes when ignited by a match, almost as if saturated with kerosene.

Several suggestions as to cause of the "explosion" have been offered, the first being that the gastight "felt" allowed such gas pressure to accumulate as to blow out the slabs; another, that when the gas accumulated sufficiently to lift a considerable portion of the scum in the gas vents, and thus instantly escape, waters from the sedimentation compartment rushed in with such velocity and in such volume as to cause water hammer to disrupt the well built partition.

The writer sent photographs and a description of the damaged tank to Harrison P. Eddy, consulting engineer, Boston, Mass., who makes the following comments:

In Imhoff tanks the gas is generated more or less continuously and at times cannot readily escape from the

surface because of the compact mass of surface scum in the gas vents. However, if the gas were free to exert pressure upon the water below the scum, it would seem that there ought not to be an unbalanced pressure upon the thin partitions.

(1) If, however, gas is formed within the mass of scum, and is prevented from escaping by the accumulation of scum both below and above the gas pocket, it can readily be seen that a considerable unbalanced pressure may result.

(2) Another theory which I think has considerable merit is that the scum formed by the rising gas-lifted sludge is compressed and wedged into the gas vents and scum space by sliding up on the underside of the partition. The shape of the sludge compartment is such that the floating scum is compressed, its buoyancy tending to carry it upward and the converging planes of the gas space causing the scum to enter a gradually narrowing portion of the chamber. Thus the scum containing considerable gas and probably also at the time generating gas, is compressed beneath and between the partitions. I think this condition may result in a substantial unbalanced pressure.

(3) Still another theory is that the failure of the sloping partition in your tanks was due merely to the lifting action of the buoyant scum. Ordinarily scum contains a very large percentage by volume of gas which imparts to the mass a great buoyancy. It may be that the oil to which you refer increased the tendency to form scum and it may also have decreased the facility with which the gases could escape from the mass. If you will make a few reasonable assumptions and computations, I think you will find that the upward pressure which could be exerted by a mass of scum is very substantial.

It seems to me that the most reasonable explanation probably requires a combination of the three theories which I have described. Probably the action described in each one played some part in causing failure.

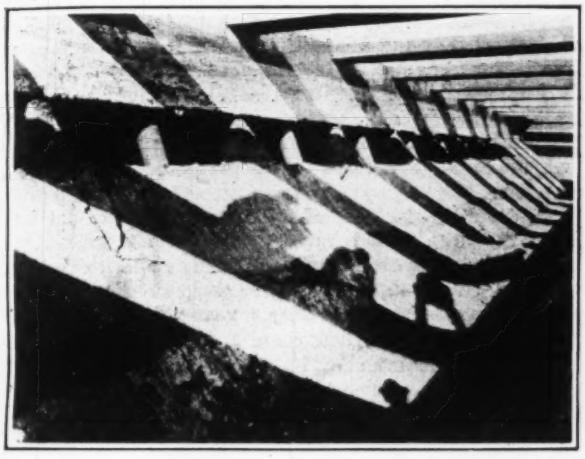
Your theory of the water hammer is exceedingly interesting, but I have never seen an escape of gas which I should expect would cause or permit an inrush of water to the scum compartment sufficient to cause an effective hammer.

The cracks, as shown low down on the partition in one of the photographs, will perhaps give some support to the water hammer theory because they are so far down in the tank. If they were caused according to either of the theories which I have proposed, the accumulation of scum must have been far greater than anything indicated in your letter. However, my experience with Imhoff tanks leads me to feel that very likely the scum did extend all the way down to the slots, in which case the cracks above referred to might be explained according to my theory.

The obvious lesson, it seems to me, is to build the partitions in a more substantial manner than is generally done and to anchor them thoroughly by means of reinforcing bars to the transverse walls.

The writer inclines toward the "water hammer" theory, but will welcome discussion and suggestions.

One thing seems certain: Scum in gas vents should be removed and disposed of before it accumulates in such quantity and density as to seal the vents.



BREAKS IN ONE UNIT OF IMHOFF TANK, FORT WORTH, TEXAS

The breaks were at opposite sides and also at opposite ends, as shown by the accompanying plan and section.

Unusual Conditions Warrant High Rail Rates

Transportation difficulties in connection with the production of gilsonite—the brittle hydrocarbon which finds such large use in insulating materials, waterproofing, paints and varnishes—are set forth interestingly in a recent opinion of the Interstate Commerce Commission. In justifying the rates charged by the Uintah Railway Co., the property of the Barber Asphalt Co., the commission analyzes the facts which contribute to high operating expense. In part, the commission says:

An engine crew and a train crew go from Dragon to Rainbow, perform the necessary switching, and bring the loaded train to Wendella, a distance of about 25 miles from Rainbow. For this movement a mikado rod engine is used. From Rainbow to Rainbow Junction, 4 miles, the grade, with an average of about 4 per cent, is with the load. From Rainbow Junction to Wendella, grades ranging from 1 to 3.34 per cent are against the load. At Wendella two Shay engines are substituted for the mikado and another train crew and engine crew take the train over the Book Cliffs to Atchee, a distance of about 13 miles. In this movement the line ascends on a 5 per cent grade with sharp uncompensated curves to the summit of Baxter Pass, 7 miles. From Baxter Pass the line begins a circuitous descent of the mountain to Atchee, a distance of 6 miles. One Shay engine is used in this descent. The uniform grade of descent on this section is shown as 7.5 per cent, with uncompensated curves of a maximum of 82 deg. and an average of 64 deg., and with practically no tangents. At Atchee a rod-type engine is substituted for the Shay and other train and engine crews take over the train for the 28-mile haul to Mack. The descending grade in this last movement ranges from 2.9 per cent at Atchee practically to level at Mack. Thus it is shown that for the loaded movement from Rainbow to Mack three train crews, three to four engine crews, and from four to five engines are employed. It is claimed that for this movement a full 10-hour day is required, and that any elimination of train crews in this movement would result in considerable overtime payment because of the location of terminal points and the homes of the crews. The Uintah is practically a one-commodity railroad. Equipment used in hauling gilsonite has to be returned practically empty, and on this return there is a 7.5 per cent grade with sharp curves over Book Cliffs.

Financing Railroad Grade Crossing Elimination

Conditions Which Make Elimination Desirable—All Crossings Should Be Classified and Placed on an Elimination Schedule—A Method of Financing Proposed

By William D. Hudson
Consulting Engineer, St. Louis, Mo.

THE NECESSITY of eliminating a grade crossing is measured by the intensity of traffic over it and the character of both railroad and vehicular movement. The great majority of crossings are not dangerous so far as loss of life is concerned, particularly those within the confines of a city. Local agitation for grade separation arises principally by reason of irritating delays to vehicular traffic, hindrance to fire apparatus, depreciation of adjacent property values, and the quite general feeling of constriction of municipal growth occasioned by tracks at grade. The hostility to grade crossings is intensified by the noise and smoke of railroad operation, the unsightliness of railroad structures and equipment and their necessarily leisurely method of operating. Violent accidents productive of considerable loss of life give impetus to the national consideration of the problem.

There is seldom any serious division of opinion between the railroads and the public as to whether or not a given crossing should be eliminated, but violent disputes arise as to the method of procedure, the proportion of cost to be paid by each, and the time of beginning work. Frequently the municipality itself is divided as to the method but seldom as to the division of cost. The railroads as a rule have difficulty in finding a legal basis for shouldering any but a small proportion of the cost upon the public. Several states have passed laws definitely fixing the percentage each is to pay but such laws do not appear to have either an equitable or satisfactory legal foundation, as is evident from their widely varying provisions. Some railroads have considerable success in treating directly and frankly with the city or community, and impressing it with the idea of mutual responsibility for conditions at grade crossings, and emphasizing the impracticability of the railroad bearing the entire burden of correcting the evil.

Dividing the Cost—It is not feasible to apply a fixed ratio for dividing the cost of all grade separation for the reason that in many cases the benefits derived are too obviously out of proportion to the share of the cost assumed. It would seem more rational to take into consideration the type of crossing, the proportionate amount of travel over it by trains and vehicles, its origin, the size of the community and hence its ability to pay; and likewise should be considered the railroad's financial standing and comparative past performance in meeting the public's wishes in such matters.

It is particularly difficult to reach an agreement where a considerable section of the business or high-class residential district of the city is occupied by railroad tracks at grade. The desire for grade separation may even be subordinate to that of improving the city as a whole and that section in particular. The public feels that either elevation or depression would perpetuate a barrier to future growth and improve existing conditions but little, so far as its general welfare is concerned. There is ample justification for this attitude and the railroads can afford to go a step out of their way in adopting a solution that will not only eliminate the grade crossing but will relieve the affected portion of the city of an industry which is not only alien but positively detrimental to it. A case in point is Syracuse, N. Y., through the retail business district of which main line passenger traffic of the New York Central flows. If there is any plan feasible other than elevation or depression on or near present alignment, it should be adopted in this case. Very often the initial cost and increased operating expense forbids any radical change in routing. In this event the city is justified in insisting upon a fairly ornamental type of construction and every possible benefit should be secured from the work, nothing being left undone that will make the structure as unobtrusive and useful as possible.

In dividing the cost of such improvements particularly the city should have a voice in the method of treatment. However, if the railroads go to a considerable additional expense for the purpose of improving property values and the city's general good in which the railroads with others have a direct but small and undeterminable interest, it is reasonable that the city should bear a somewhat larger proportion of the expense than if the less costly and more suitable method from the railroad's standpoint had been adopted. No uniform rule for dividing the cost can be applied to such cases. It is possible by appraisals to estimate the new value of the abutting and adjacent property if the tracks are entirely removed and thus arrive at a figure which would indicate about how much of the additional cost the city could afford to assume. To this the railroads would be justified in adding at least some portion of the increased cost of construction, maintenance and operation, over and above that which the simpler plan would entail. If the railroads own property in the affected district, the new value should be applied to it and the proper credit allowed. It is evident that negotiations on such a basis grow quite complicated, but if there is a wide difference in the cost of the projects these detailed comparisons are justified.

Classes of Grade Crossings—In considering the division of cost it is convenient to divide grade crossings into two general classes, namely those located within cities and those of the rural type located beyond cities on highways chiefly utilized for through vehicular traffic without local movements. Included in the first general group are those crossings of long standing over which both railroad and street traffic have been gradually increasing in volume and which are fully protected by watchmen and gates. Frequently these crossings are made of quite a number of tracks comprising portions of railroad yards. If the tracks are as many as from 4 to say 20, it is quite likely that the railroads

are undergoing a heavy expense for maintaining watchmen, signal towers, crossing gates, pavements and sidewalks. The railroads on account of the crossing are perhaps operating at a disadvantage owing to the necessity of limiting the length of their trains, interrupted switching, occasional collisions with vehicles and personal injury occurrences. All of these items are determinable quantities and represent directly the advantage to the railroad of eliminating such a crossing. Occasionally, but not often, conditions become such that railroads voluntarily undertake to better their condition with little or no expense to the city, and it is evident that in the division of cost of such work the proportion to be paid by the railroads should be greater than that where only one or two tracks are involved and the street traffic itself is extraordinarily heavy. In a number of cities the cost of eliminating single crossings of this class has been adjusted on a basis of from 25 to 40 per cent payable by the city and from 60 to 75 per cent payable by the railroad. In consideration of the larger proportion paid by the city the type of structure adopted is more ornamental and enduring than if the railroad built it at its own expense.

It is the general custom for the maintenance of an overhead structure to be borne by the city and that of subways by the railroad.

Where there are only from 1 to 4 tracks carrying main line traffic across an important city thoroughfare the advantage to the railroads of eliminating such a crossing is likely to be small compared to the benefits derived by the public. Neglecting what is generally considered the inherent right of cities to require the elimination of any crossing at no expense to itself and basing the division of cost only upon corresponding advantage gained, it appears that the city in such a case could bear more of the cost than the railroad.

Another class of grade crossings within the city limits comprises those of isolated streets or boulevards which the rapid expansion of the city combined with normal train movements have made dangerous or productive of delays of unusual length. Streets hitherto merely platted have become major thoroughfares. Usually such crossings have only one or two railroad tracks and so far as the railroad is concerned the crossing could remain indefinitely at grade without serious inconvenience to it. Again, the advantages to the city of eliminating this type of crossing are decidedly in excess of those to the railroad and hence the railroad may argue that the city can afford to pay a larger proportion of the cost of work.

Complete Elimination—Where the main line track of one or more railroads extends entirely or partially through the city, crossing all streets at grade the solution of the problem calls for a general program of elimination, the expense of which will be great. After a careful study the method of elimination is adopted, and is usually one of either complete elevation or depression or a combination or modification of the two, with perhaps some relocation. The program is such that it must be considered in its entirety and the division of cost is usually worked out to cover the entire job. If the method is well chosen the railroad will secure decided benefits in the nature of easier grades, freedom from maintenance expense of crossings and delays, better accessibility to industries and possibly a shorter route. All of these advantages should have some influence in determining the division of cost. Ordinarily, cities do not feel called upon or able to pay any but a portion of the cost of the structures at the streets and possibly damages to abutting property occasioned by changes in street grade. After agreeing upon the division of cost it is desirable to apply a fixed ratio to the entire program in order to simplify accounting methods, issuance of city bonds, payments for the work, the formation of a logical construction program, and to assure an equitable division of contingent expenses. In a general program such as this it is not wise or just to set the proportions by statute.

Rural Crossings—Regarding the second general class of crossings, that of a rural nature outside of the city limits or within villages and extremely small towns, it is the general rule that the railroad derives the least benefit from the separation of grades and from its standpoint the railroad's proportion of the cost should be correspondingly smaller. Owing to the inability, however, of rural communities to finance any but the most unimportant projects, it is usually impracticable to assess a very high cost against them and in such cases it is within reason, and in certain instances customary, that funds for the work be to a large extent supplied by the state itself or by the national government. If the crossings are on continental highways, it is not unjust to assess the entire cost against the government especially in the case of newly created routes. The reason for this is that both local benefits and those to the railroads are insignificant and that the great advantage of the elimination will redound to the general public and to auto truck lines which carry both passengers and freight in competition with the railroads.

Minor Crossings—Yet another type of grade crossing is that made by slow-speed intermittent switching lines and spurs to more or less isolated industries. There are literally thousands of these which are harmless and which it would be a sheer waste of money and effort to disturb.

Legislation—Although it is impracticable to establish by statute a definite and equitable division of cost for eliminating all grade crossings, it is believed that a useful law of national application can be evolved. Such a law should take into consideration the ruling features of each class of crossings.

In order to accomplish much in eliminating grade crossings, it is becoming apparent that neither the railroads nor the cities can continue to assume too great a share of the cost of work. Many cities appear to have reached or nearly reached their maximum bonding power and the financial inability of the railroads to meet the entire cost of such projects is fairly well known.

The railroads are able to endure conditions at grade crossings much longer than the public and hence the initiative for elimination will continue to originate with the public. It has been stated many times and is a stock argument, that in order to eliminate all crossings an expenditure of almost 20 billions of dollars would be necessary; but every one must realize that all crossings do not require elimination. So far as known no one has classified the actual crossings in the United States, both within and without municipalities, that really require a separation of grades or other treatment but it is probable that they will not exceed 10 per

cent of the total number. In other words the expenditure of $2,000,000,000 would give satisfactory relief.

Although a laborious task, it is suggested that in order to simplify the problem the grade crossings of each railway system be classified and arranged somewhat in the order of their importance and that their elimination proceed correspondingly. At present it seems to be the policy of the railroads to eliminate crossings in those cities with which they can make the most favorable terms; they are also inclined to favor cities of greater revenue producing power and feel disinclined to spend money in a community where there is little chance of early reimbursement.

It would seem just also that each railroad undertake a share of the work in proportion to its capitalization, mileage or financial condition; and cities should participate according to size and bonding power.

Finally, the problem has become one of such widespread importance and the use of the highways by transportation agencies operating in direct competition with the railroads has become so increasingly intense that it is believed the national government should assume a larger share of the cost of all grade crossing elimination and should also undertake to formulate a program of work for each section of the country.

As a means of financing the work painlessly and without direct taxation it is suggested that the railroads be granted a flat increase in all freight and passenger rates, the resulting revenue from which to be applied exclusively toward the elimination of grade crossings. The operating revenue of Class I railroads alone amounts to over $5,000,000,000 annually. A flat increase of one per cent would produce an additional $50,000,000 per year for grade-crossing elimination.

Partial Failure of Earth Dam at Horton, Kansas

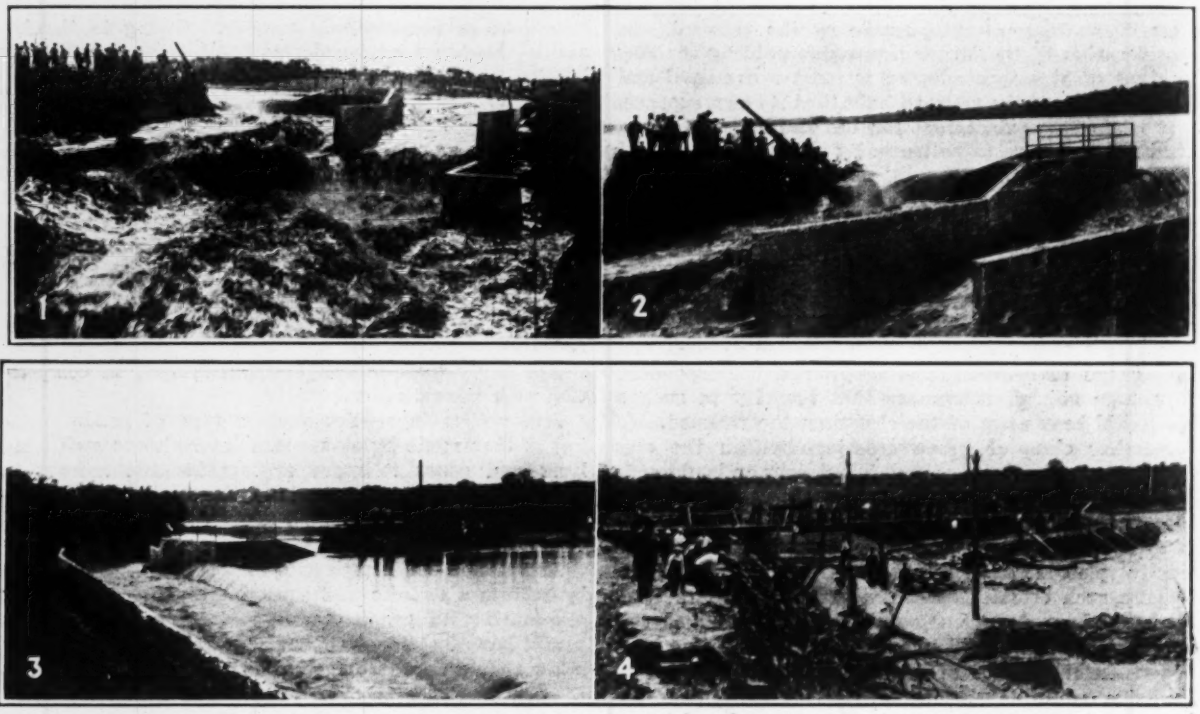
Record-Breaking Rainfall Overtops Structure and Washes Out 50 Ft. Part Way Down—Quick Emergency Work

By E. B. Black

Of Black & Veatch, Consulting Engineers, Kansas City, Mo.

THE DAM forming Mission Lake from which the city of Horton, Kan., secures its water supply was topped by a flood on the morning of June 18, and a break opened through the earth fill next to the concrete spillway. Prompt action on the part of the citizens of Horton closed the break when it had reached a width of about 50 ft., and the lake level was held at such an elevation that approximately 500 m.g. of the water stored above the dam was saved. Black & Veatch, designers of the dam, started emergency reconstruction the afternoon of June 18 and at this time (June 30) the break has been refilled, and in a few weeks the permanent repairs will be completed—all at a cost of not over $10,000, including the provision of additional spillway capacity. This storm covered a considerable area in northeast Kansas, but neither loss of life nor damage to crops was caused by the escape of water through the breach in the Horton dam.

This dam was constructed in 1923-24. It is of the earth fill, clay core-wall type, with the upstream face of the dam protected from wash by a reinforced-concrete slab (see *Engineering News-Record*, June 4, 1925, p. 931). Throughout the season of 1924 scarcely enough rain fell on the drainage area to supply the needs of Horton. On June 2, 1925, a 5.05-in. rain fell



VIEWS SHOWING PARTIAL FAILURE AND BEGINNING OF REPAIRS, EARTH DAM AT HORTON, KAN.

Views (1) and (2) show the break looking upstream from below spillway end of dam and view (3) shows break from above, looking along spillway overflow, all taken 9 a.m. day of break. View (4) taken June 24 shows repairs to break, also, in foreground gap in spillway made by dynamiting, on the day of the break, to clear channel and as safeguard in case of another heavy rainfall before permanent repairs completed.

on the drainage area, and brought the water to within about 10 ft. of the spillway weir. Rains followed on June 11, 12, and 14, and on the night of June 15-16 a 4-in. rain fell which raised the water approximately 7 in. over the spillway. On the night of June 16-17 there was a slight rain, but the water in the reservoir had run down to approximately spillway weir elevation, practically no water going over the weir. Beginning at 10:30 p.m., June 17, and ending at 3 a.m., June 18, a 4.48-in. rain fell. In less than three hours after this rain commenced falling water had topped the earth fill at the east and west ends of the dam with the result that at a low point, caused by settlement and wash from heavy rains, joining the spillway concrete, a breach was formed and quickly widened until it was approximately 50 ft. across. [The engineers for the dam had advised the city authorities more than once that this settlement needed attention.—EDITOR.] A call for volunteer workers was turned in about 3 a.m., June 18, and the Rock Island Ry. relieved all men in its shops from duty. The J. B. Watts Construction Co., at work on paving for the city, and the citizens of Horton generally responded and assisted in the work. The water flow through the breach was under control before 9 a.m., June 18.

The rainfall June 2-24 on this reservoir area, gagings of which are made by a government rain gage located at the city hydro-electric and pumping station about one-fourth mile below the dam, according to readings taken at 8 a.m., for the preceding 24-hr. period, were:

Date	Inches	Date	Inches	Date	Inches
2- 3	5.05	15-16	3.95	22-23	0.22
11-12	0.63	16-17	0.27	23-24	0.25
12-13	0.80	17-18	4.48		
14-15	0.55	21-22	0.07	Total	16.27

Approximately 50 per cent of the annual rainfall for this vicinity occurred in the 22-day period between June 2 and 24, and a total of 15.73 in. fell in the 12-day period prior to the damage to the dam. Calculations of the probable intensity of the storm on June 17-18 and time of concentration on the drainage area, are being made.

Between 1888 and 1925, the U. S. Weather Bureau reports a total monthly rainfall of 13.32 in. for May, 1903, 10.51 in. for May of 1896, and 10.49 in. for June, 1908. The highest rainfall reported for the remainder of that period, excepting June of 1925, was 9.22 in. in May, 1910. The mean annual rainfall for May in the period 1888-1917 was 5.13 in.; for June, 4.66 in.; for July, 4 in.; and the mean average annual rainfall for the same period has been 33.13.

The nature of the work undertaken by volunteers prior to the arrival of Mr. Veatch and myself at Horton was to stop the breach by the use of trees and timbers lashed together and weighted with sand bags. This work started about 5 a.m., June 18. In order to slow down the current through the break and expedite the work, the cutoff wall at the extreme north end of the spillway was dynamited about 9 a.m. and the north section of the spillway weir a short time afterward. This lowered the water at the break so the men could work more effectively.

The preliminary work, when completed on the afternoon of June 19, had resulted in the building of a sand-bag dike weighting down trees and brush and held in place by timbers and cables, from the upstream face of the dam at a point 70 or 80 ft. west of the spillway, to the spillway weir wall at a point about 30 ft. north of the concrete abutment at the northeast corner of the earth fill. This work also included the protection by sand bags of the east end of the earth dam to a point above the water running through the break.

By the evening of June 18 the water through the break could be easily carried through an 18-in. corrugated pipe. On the morning of June 19 we raised the outside sand-bag dike, cleared out the channel immediately below this dike and through the dam, of all concrete slabs, trees, etc., placed a 12-ft. section of 18-in. corrugated culvert pipe in a position where it would carry the entire flow then coming through the brush and sand bags, and started a new sand-bag and clay dike below the former dike and about 4 ft. away from it, leaving room to reconstruct the fill on its original location. The space between the two dikes was packed with clay as the lower dike was raised, and on reaching an elevation above water in the lake, the culvert was stopped with sand bags and clay. This reduced the seepage and flow through the break to a point where it could be easily handled by an ordinary trench pump and allow the starting of permanent repairs.

In making permanent repairs we excavated along the center line of the original clay core-wall to shale and rock underlying the dam. Wakefield piling was then placed in this ditch along the line of the original clay core-wall, from the concrete abutment to a point about 50 ft. west of the abutment. A temporary bridge was built across the spillway and across the break and filling was started on both sides of this Wakefield piling by means of horse-drawn wheelers and ordinary scrapers, the clay fill being puddled as deposited. On the evening of June 25 the clay fill had reached a sufficient height to dispense with the bridge across the break and allow teams to get directly on the fill, and on June 27 the clay embankment had been restored to a point about 2 ft. above its original elevation, to allow for settlement, and filling was started at the downstream toe of slope to the west of the south end of the concrete spillway.

We plan to protect the upstream slope of the new fill by sand bags until settlement has stopped, at which time we will surface the upstream face of the fill with concrete slab as originally constructed. Until this work is done, the sand-bag dikes will be left in position to protect the embankment and the new concrete work.

Concerning the nature of the permanent repairs, as far as the dam itself is concerned, these repairs will merely carry out the original plan of construction, Wakefield piling in the clay core-wall being added to prevent the possibility of the repair work being washed out by a storm which could not be handled by means of temporary sand-bag dikes.

The extent of the new work done on the spillway will be to replace the old spillway weir wall to its original length and possibly extend it 12 or 15 ft. to the north in order to get around the cutoff wall which was dynamited on June 18, and which we cannot remove to its rock base without considerable expense. The channel below the spillway weir will then be widened but at this writing (June 30) the details of this widening have not been finally decided upon. It is certain, however, that we will plan to take care of the very unusual rainfall condition which developed in the twelve days preceding the break on June 18.

Engineering in the Small City

A series of notes from the field on the Problems and Practices of the Municipal Engineer in the Cities Below 100,000

The Editor Visits the City Engineer

Snapshots of Our Representative Small Cities

Greensboro, N. C.

OFFICE BUILDING, GREENSBORO N.C.

COUNTY SEAT OF GUILFORD COUNTY, 81 miles north by west of Raleigh. Carries on considerable trade in tobacco, cotton, coal and iron, and manufactures spokes and handles, bent rims, bobbins, cotton-mill supplies, cotton and woolen goods, carpets, fertilizer, stoves, sewer pipe, cigars, flour, brick and tile. Owns and operates its water-works. Home of a number of institutions for higher education. Settled in 1808, first chartered 1870. Battle of Guilford Court House fought near site of city, 1781. Pop. (est. 1924) 45,000.

LITTLE more than three years ago the city of Greensboro contained about 20,000 population within its two-mile square corporate limits. Mills outside this perfect square housed their employees in endless rows of white houses, but they were without the corporate limits of the city and were not given municipal sanitary water supply and transportation service, nor police and fire protection. There were supposed to have been at that time twenty-one miles of paved streets, the increment of the city's century of life. Then new ambition seized the city. Its corporate limits were extended. It discarded its government by commission and decided to try the city-manager system. Whether the experiment is going to succeed lies largely with the present administrative organization, but the quickening in public improvements and the refinements in administrative control lead one to believe that the change has been a decidedly happy one.

The present population of the city is around 45,000. A special U. S. census taken in 1923 after the extension of the city to include an area of 16.3 sq.mi., showed it to be 43,525. Immediately upon the appointment of a city manager and the completion of the general municipal reorganization it embarked upon a paving program alone which in the last three years has added a paved mileage of forty-seven miles, or almost two and one-half times that done for the entire previous life of the city. Petitions for paving on record for the year 1925 total thirty miles. Since water main replacements and extensions and sewerage facilities must keep pace with the paving, it is obvious that Greensboro has been a busy municipality during the past two construction seasons, in which time approximately $1,500,000 has been spent on such work per year.

When the municipal reorganization was effected in 1921 power of selecting both a mayor and city manager was vested in the city council. The city is divided into two districts, the general district and the mill district. From District 1, the mill district, is elected one councilman, and six councilmen-at-large are elected from the other. Selection of the mayor from one of their number by the council rather than by popular election is a diversion from the usual procedure worthy of passing mention. The city manager was empowered to appoint the heads of all departments, including police, fire, health, etc., and all personnel. The various city departments have undergone another reorganization which became effective June 1 and which affects the engineering services as follows:

One engineer as superintendent of the water department in charge of water supply and distribution including water-works and filtration plants and reservoirs; an engineer in charge of new paving including sidewalks and alleys and the construction of new storm sewers, bridges and culverts; a general superintendent in charge of the maintenance of storm and sanitary sewers, streets and water lines; and fourth, an engineer in charge of new construction of water and sewer lines and all new plant construction in connection with the water department. An engineer is in charge of all preliminary surveys and it is his duty to prepare plans of all streets on which paving, storm water or sanitary sewers or water lines are to be laid and both the highways department and the street and water departments use these plans and profiles thus avoiding a duplication of survey work. This department also is charged with the keeping up of the city topographical map and block survey map. With this new assignment of duties it is hoped to carry forward with the minimum of effort and expense the large program of improvements. The city manager, P. C. Painter, is a civil engineer and acts as chief engineer for the city. George E. Finck, highways engineer, is in charge of streets and storm sewers. M. M. Boyles, water and sewer engineer, is in charge of the new water and sewer construction. C. W. Smedberg is the engineer in charge of the filtration and pumping plant and water-works equipment. T. K. Roberts is chief of surveys and is in charge of the survey department. Thus troubling engineering matters can be given the benefit of technical advice by a man directly responsible for any of the city's services.

Inasmuch as Greensboro has added considerable territory in the past few years, it has had the experience of trying to fit its streets with those of the communities it incorporated, where grades differed and street widths might not be the same. With this experience and as considerable new territory has been developed since the increase in the size of the town, it has adopted means of harmonizing new streets to existing ones which many other cities with similar problems would do well to imitate. Now no property within the city limits can be subdivided and offered for sale without strict adherence to existing street, water and sewer layout to which it proposes to tie.

Such subdivision plans must first be filed with the planning commission showing proposed new streets and those existing, and this plan is checked by the city survey department. The sub-divider must then obtain from the city council approval of such a layout. Surveys and maps must be made under the supervision of a surveyor or engineer licensed to practice in North Carolina. Surveys must be made in accordance with

best modern practice and any elevations shown on the plat of the new subdivision must be run from one of the city's precise bench marks and based on that datum. Permanent corners shall be put in as prescribed by the city chief of surveys. Each plat must show bearings and distances of all street lines, length of tangents, radii, arcs and chords and central angles for all curves, street widths at intersections, easements and their widths, building lines with the distance of the setback from the property line indicated, and all land markers of a permanent character. All existing streets, public roads or alleys within 100 ft. of the subdivision boundaries must also be shown. In addition, grading, paving and sidewalk work is to be done under the supervision of the proper engineer of the city. Major traffic streets are to be given a width of not less than 70 ft. between property lines and minor streets not less than 50 ft.

Construction—With a paving program of large expenditures it is apparent that extensive plant must be provided for. The city contracts for all of its work, a satisfactory original contract having been made with the Murray Construction Co., Knoxville, Tenn. That firm is doing all of the paving, which, by the way, during 1924 amounted to a greater mileage than that laid by Milwaukee, Wis., and other cities of a like size. The plant and equipment of this contractor are located just outside of the old city limits, convenient to railroad transportation and the work involved. In value, equipment operated, which includes a fleet of 22 trucks, asphalt plant and shops, is around $200,000. The value of materials stored at this plant on May 1 amounted to $330,000. This included 30,000 tons of crushed stone for concrete base alone. Obviously this outlay taxes the financial strength of the contractor, so the city pays each month for 90 per cent of all paving materials delivered to this yard. As paving is completed such cost is deducted from the final payment. The city retains 10 per cent of the total cost of the paving until the six months' guarantee has expired. These 90 per cent completion payments are also on a monthly basis. The average daily performance of the contractor is 2,000 sq.yd. of concrete base and completed pavement. As high a daily performance as 2,800 sq.yd. of concrete base has been recorded.

The city is laying practically nothing but sheet asphalt or a modified topeka on a concrete base. The concrete base is of a 1:3:6 mix either 5 or 6 in. in thickness. The subgrade varies, but usually it is sufficiently firm to avoid the use of reinforcement. Topeka of a 2-in. thickness is laid. Sheet asphalt is put down either with a 1-in. binder and a 1½-in. top or 1½-in. binder and 1½-in. top. Exclusive of grading the topeka has cost $2.36 on a 5-in. concrete base and $2.56 on a 6-in. base, and the sheet asphalt has varied from $2.59 to $2.81 per sq.yd. Grading has averaged from 50 to 65 cents per cu.yd. The city maintains an inspecting engineer at the plant. Reports on sand and aggregate grading and asphalt and concrete mixtures are taken regularly, those on asphalt being twice daily.

Financing of paving is by short-term bonds. It is considered best to have bonds retired before the paving has begun to deteriorate badly, so all construction work is paid for on the ten-year basis. Property owners pay for the entire cost of paving abutting their property, but the city pays for curb and intersections. Thus the city bears about 25 per cent of the total improvement. As the bonds are retired at ten years property owners are given the privilege of spreading payments over a like period, with payments at 6 per cent interest.

Aside from its large paving program Greensboro has kept its sewer and water lines apace with paving. A minimum of 6-in. water pipe is now put in. The city is rather flat and it has an inadequate storm sewer system and studies have been made looking toward the installation of a modern and comprehensive system. Greensboro is only a voluntary meteorological station, so runoff figures are not available. However, taking figures of nearby cities of which Greensboro is the center, a figure has been arrived at which indicates that storm sewers must provide for a maximum of 2.5 in. rainfall per 24 hours. Contracts for the storm water system will be in shape for letting in the early spring of 1926. Storm water now is led, as best it can be, by surface or covered drains into the nearest waterways, and these waterways will be improved and used as the major outfalls.

The water supply of Greensboro is in good condition, a new filtration plant with six 1-m.g. units having been built but two years ago. Water is taken from Reedy Fork Creek about seven miles from the city, and pumped from a billion-gallon impounding reservoir to a twenty million-gallon reservoir from which it flows 6 miles by gravity through two 24-in. mains (one cast iron and the other wood) to the filtration plant. Pumping is necessary to the service mains, however, and water is delivered through a 200,000-gallon steel standpipe as a pressure equalizer. Installation of two 6-m.g.d. high-pressure pumps, one at the impounding reservoir and the other at the filtration plant station, will adequately care for the city's needs for some time to come, as there are already in service at these stations one 6.5 m.g.d. and one 7.5 m.g.d. pumps.

As is the case in numerous other instances the disposal of sewage is a problem which must be solved in the not distant future. It appears that original sewerage installations never took into consideration the growth of smaller communities that might want to take their water supplies from streams into which the older and larger communities discharged sewage. General condensation of population in the older communities has forced upon numerous old cities expensive sewerage problems. In cities half a century old or older, that and additional water supply are the big problems. In Greensboro the situation is typical so far as sewage disposal is concerned. There is no central disposal plant. Four small septic tanks give sewage some degree of primary treatment. Tanks are cleaned of sludge and all periodically, but undoubtedly sooner than later expensive intercepting and disposal works must be installed.

Sidewalk Construction in Lynchburg, Va.

Since 1916 when less than 500 ft. were laid, sidewalk installation in Lynchburg, Va., reached a peak during 1923 when 23,488 lin. ft., or almost 4½ miles, of one-course concrete sidewalks were constructed. This mileage is over 50 per cent greater than the 1922 mileage, which in turn was a record up to that time. In connection with this work, 3,400 lin. ft. of encroaching walls and fences were moved back to the true property line, thus reclaiming to the city for public use approximately 4,800 ft. of land.

Well-Managed Private Water Plant at Lexington, Kentucky

Why Its Manager Became A.W.W.A. President, How He Pays Dividends from Old Rates, and High Meter-Reading Record

(Staff Correspondence)

ONE reason why W. S. Cramer became president of the American Water Works Association a few years ago and was chairman last year of the Association's Division of Plant Operation and Management is because he has aroused the interest of the membership by his marvelous tales of water-works operation at Lexington, Ky. In these stories, which all finally accept, although the one on meter reading seems too good to be true, Mr. Cramer tells how he ran the plant of the Lexington Water Co. through and since the war of 1914-18 on the water rates of 1885; of meter reading at the rate of 70 per man-hour; of keeping what he calls a small antiquated pumping and filtration plant going with a minimum of new capital outlay; and of instrument equipment and record keeping which are unusual for a small pumping station. Add to this his geniality and hard work at the water-works conventions, his long managership at Lexington, and the fact that his father preceded him and his two sons are his able lieutenants and it is no wonder that W. S. Cramer is generally accredited as one of the most popular and successful water-works superintendents in the United States and Canada.

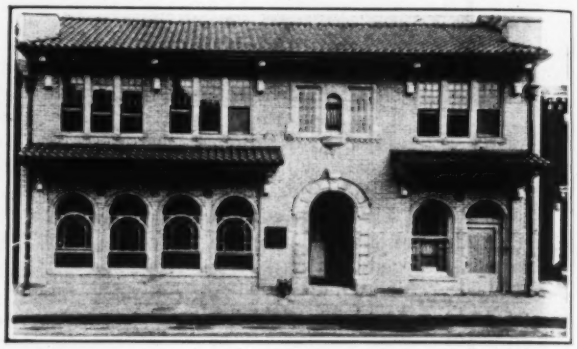
To begin with the record of the Cramer family as water-works men: F. A. Cramer, father of W. S. and grandfather of Hugh R. and Clark Cramer, was erecting engineer for the old Holly Manufacturing Co. As such he put in the original pumps at Lexington in 1884 and from January, 1885, when the plant was put in operation, until March, 1888, he was chief engineer of the Lexington Hydraulic & Manufacturing Co. He was succeeded in that position by his son, W. S. Cramer, who has also been general manager since 1904, at which time he succeeded S. A. Charles who had been manager since 1884. As time went on Hugh R. Cramer grew naturally into the position of assistant chief engineer of the company, in charge of the pumping plant and filters. Later, Clark Cramer became second assistant, after three years in the engineering school of Kentucky University. The latter now keeps the boiler, pump and feed records and wields the slide rule to determine some of the end results in operation efficiency.

The family as a factor in the smooth and efficient working of the Lexington Hydraulic & Mfg. Co. and its successor (since 1922) the Lexington Water Co., extends beyond engineering and general managership. A majority of the stock of the company, acquired by Lexington people from its northern owners in 1904, is in the hands of the Stoll family, with John G. Stoll, owner of the Lexington *Leader* and other Lexington enterprises, as president.

The main features of the works today are two series of impounding reservoirs, the drainage area of which is largely owned by the company; an interesting assemblage of old and new pumping plant equipment; rapid sand filters, the first one, 30 years old, and newer ones squeezed in here and there; meters on every consumer; and a brand new office building.

The works were built by northern capital in 1884-5.

Ownership of the company's stock passed to local capitalists in 1904, which has made the path smoother for Mr. Cramer since then. When the late war came on the works were in fair condition and there was an ample reserve. This and careful management enabled the company to keep up its service on the water rates established by the 50-year franchise effective in 1885, maintain dividends and add slightly to the reserve fund; but it has required much patience and ingenuity to do this and meet the increasing demands of a growing city. One means to that end was the revamping within the past few years of the boiler plant, the provision of recording instruments as an aid to more efficient operation, and the addition of pump capacity, all for $50,000. Coal consumption has been reduced from 32,000 to 20,000 lb. per 24 hr. in the last three years, with a 5 per cent increase in water use (4 to 4.2 m.g.d.).



NEW OFFICE BUILDING OF LEXINGTON WATER CO.

The instrument equipment which some water-works men think too extensive for so small a plant includes a boiler draft gage, thermometers for breech and feedwater temperatures, a CO_2 recorder, recording steam and water gages, a Venturi water meter on the boiler feed line (not recording) for checking up, a recording Venturi meter on the raw water line and a pitot tube, with recorder, on the filtered water line to the city. The latter is accurate except for very low flows.

Among the factors making for economy and general efficiency of operation is machine repair work done at the pumping station. Repairs are made quicker and at less cost than would be possible if the part were taken to a city machine shop. A broken pump rod late one afternoon is a case in point. Steel was obtained, machined, the new rod in place and the pump back in use within 13 hours, or before any of the city shops would have been open next morning. The new steel was almost the only extra expense the company had to bear, for although the entire staff of the company is on the 8-hr. basis there is no overtime pay for emergency work.

The boiler pump and filter plant records are entered on facing pages in a large oblong-sheet ledger which gives a complete daily log, with monthly totals and averages. There is continuous check on boiler and pump efficiency.

The sand agitators have been removed from the old Jewell filters—none provided for the later ones. The

Of the Small City

first filters were all sand. Gravel was used later but sand alone gives the best results. At times the filters have been worked at a rate of 140 m.g.d. per acre.

Crude attempts at filtration or straining through sponge were made in the early days. The mechanical filters of 1894 were one of the relatively early plants of the kind. Copper sulphate to keep down tastes and odors has been used since 1900. Chlorination with chloride of lime dates from 1909 and with liquid chlorine from 1920.

The impounding reservoirs are shallow and cover 475 acres when full or about 6 per cent of the total drainage area (land and water) of 8,159 acres. Of the 2,756 acres of drainage area nearest the city the company owns 1,141 acres or about 40 per cent, and of the larger area of 5,403 acres it owns 1,079 acres or about 20 per cent. Of the land under water, the company owns 98 per cent. The acquisition of the land not under water began in 1891. As high as $300 an acre has been paid for some of the land. Most of the dry land owned by the company is rented for use as horse breeding and dairy farms.

Sanitary protection throughout the watersheds is maintained by the company and by county health department inspection. Septic tanks, in some cases with subsurface drain outlets, receive sink and bath wastes. "Kentucky privies" (virtually septic tanks) and also ordinary concrete privy vaults are provided, the contents of the latter being removed to city sewers.

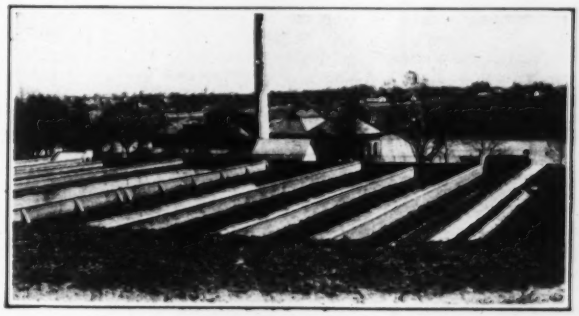
With but 13 square miles of drainage area to supply a population of 45,000 within and 7,000 outside the city, largely dependent upon the company's supply because of the limestone formation, the closing of city wells by the health department, the growing population on the watersheds, and the outgrown pumping and filtration plants, an additional supply of new pumps and filters must be had before many years. Studies to this end are being made by Alvord, Burdick and Howson, of Chicago. The water distribution mains within the city of Lexington total 83½ miles compared with 75 miles of streets and 60 miles of sewers. In size, the mains within the city (all cast-iron) range from 20 in. downward as follows: Above 10 in., 14½ miles; 8 in., 11; 6 in., 49; 4 in., 8½; under 4 in., ¾ mile.

With 100 per cent of the taps metered and the people dependent on the water supply the average daily consumption is 85 gal. per capita. It would be higher yet were there not many houses of such a character and tenantry as to have no inside water supply while many houses that do have running water are on streets without sewers, with little if any plumbing except a kitchen faucet. In some quarters a household that has a yard "hydrant" is fortunate, while some carry water from "hydrants" located at a distance.

Further light is thrown upon house water supplies in Lexington by the fact that, with a meter rate of 25c. per 1,000 gal. for the first 25,000 gal., shading down to 10c., 38.3 per cent of all the consumers paid the minimum monthly charge of 50c. last year.

This brings us to Mr. Cramer's speed record for meter reading and its explanation: All meters are placed at the curb and have direct-reading dials, on extensions that bring the dial to the surface. Not only are meters read at the rate of 70 per man-hour, says Mr. Cramer, but except for 400 to 500 meters outside the city all the monthly readings are made in four days, by four men. There is but one "regular" meter reader and most of his time is put in as plumber for the company. This man takes all the daily and weekly meter readings, in about 4 hr. per reading. He is also meter trouble-man. The other three monthly readers are (1) the man in charge of meter repairs; (2) his assistant; (3) the hydrant inspector. Critics have said that even if all in one room, 70 meters could not be read by one man in a single hour. Mr. Cramer says perhaps it couldn't be done elsewhere but it is done at Lexington.

The meter cards are turned in to an office man, posted in ledgers as cubic feet, and as gallons, with the charge in dollars and cents—these computations being made with the aid of conversion tables. Bills are paid



LEXINGTON PUMPING AND PURIFICATION WORKS
Looking over coagulation basins, filter and pump houses and end of reservoir to the blue grass stock farms on the water gathering grounds.

in person at the office or by check, some being mailed to banks and charged to checking accounts, by agreement.

The entire office staff under Mr. Cramer consists of but five persons, but of these the man in charge of meter cards does off-and-on service. The office floor is 28x64 ft. in plan: a public lobby, 10x24 ft.; counting room, 20x48 ft. inside the rail separating it from the lobby; Mr. Cramer's office, 15x18 ft.; president's office, 15x20 ft. The office is on the main floor of a new two-story brick building, with residence rooms above.

The history of the Lexington water-works shows what can be done in private water company administration by keeping the operation management in the hands of one man for forty years when that man is of the sort to grow with the plant. The record in this case is all the more notable because although there has been no change in rates for forty years yet a dividend of 10 per cent was paid from 1905 to 1922 and 9 per cent since then. (The capital stock was increased from $300,000 to $400,000 in 1922; a valuation slightly over $2,000,000 was placed on the property by Alvord & Burdick in 1915.) This has caused heart burnings on the part of representatives of other companies when mentioned at water-works conventions. Presumably it has caused too close sailing to the wind at times and it may call for readjustments later on when heavy expenditures for a new supply and other improvements are undertaken. But the finances of the company and the good feeling caused by local ownership of the stock and the success of a recent public offering of preferred stock in blocks of not over $5,000, with a constant waiting list for the stock, augur well for a successful future.

Concrete Section Abstracts, Testing Materials Meeting

High Alumina Cement and Its Curing, Concrete for Highways, Bond with Steel and Form of Test Specimens Discussed by American Society for Testing Materials at Atlantic City

Temperatures in High-Alumina Cement and Methods of Curing

By H. S. Mattimore
Engineer of Materials, Pennsylvania Department of Highways, Harrisburg, Pa.

During some experimental work undertaken by the Pennsylvania Department of Highways, to test the efficiency of a high-strength-alumina cement for the purpose of making early high-strength concrete, it was noted that defective surface conditions resulted when such concrete was cured by methods which had been effective in the curing of portland-cement concrete. Accordingly, several series of test slabs were cured under two conditions, one, a combination of wet burlap and ponding curing, and the other ponding curing alone. Provision was made in this test for the measurement of the temperatures in the slabs at various periods during curing. The surface conditions are distinctly better in the case of the latter method of curing.

The effects upon this phenomenon of the age of the high-alumina cement were studied and comparative tests of mortar and concrete of high-alumina and portland cement comprising tension and compression tests of mortar and transverse compression tests of concrete were made.

The following definite conclusions are drawn:

(1) High-alumina-cement has compressive and transverse strengths at 24 hours greater than those of portland-cement concrete at 28 days.

(2) Wet burlap curing, effective for portland-cement concrete, increases the temperature during hydration and produces a defective surface when used with high-alumina-cement concrete.

(3) Application of moisture at too early stages, either by sprinkling, ponding or covering with wet burlap, produces a dusty or scaled surface.

(4) Water curing should be started when hydration is well under way as indicated by a rise in temperature. This can be detected by a stiffening of the surface and a drying out appearance. Under laboratory humidity and temperature the safe period was 7 hours after mixing.

(5) Storage or air curing in bags reduces the high temperature during hydration and also delays the hydration. After four months storage in bags the hydration was delayed about two hours.

* * *

Effect of Size and Shape of Test Specimen on Compressive Strength of Concrete

By Harrison F. Gonnerman
Associate Engineer, Structural Materials Research Laboratory, Lewis Institute, Chicago

This paper described compression tests to determine the effect of the size and shape of test specimens on the compressive strength of concrete.

The tests were made at 7 days to 1 year on 1,755 concrete specimens in a study of the compressive strength of:

1. Cylinders 1½ to 10 in. in diameter and 2 diameters in length, when such factors as size and grading of aggregate, mix, consistency and age were varied over a wide range.
2. Cylinders 12 in. in length ranging from 3 to 10 in. in diameter.
3. Cylinders 6 in. in diameter ranging from 3 to 24 in. in length.
4. Cubes, 6- and 8-in.
5. Prisms, 6 x 12 and 8 x 16-in.

Most of the tests were made at 28 days on 1 : 5 and 1 : 3 concrete of relative consistency 1.10, using sand and pebble aggregate graded 0-1½ in. The relative strengths of the different forms of specimen were compared with the strength of 6 x 12-in. cylinders from the same concrete.

The principal conclusions from the test are:

1. The 6 x 12-in. cylinder generally used for compression tests is a satisfactory form of specimen. However, because of the likelihood of non-uniform placing it is recommended that the use of this size of cylinder be limited to aggregates 2 in. or less in diameter.

2. The 4 x 8-in. or 5 x 10-in. cylinders are suitable for the smaller sizes of aggregate. The ratio of diameter of cylinder to maximum size of aggregate should not be less than about 3. For aggregates larger than 2 in., 8 x 16-in. cylinders or larger should be used.

3. For cylinders of length equal to 2 diameters, lower strengths were generally obtained with the larger cylinders. The decrease in strength with size of cylinder was not important for diameters of 6 in. or less; 8 x 16-in. and 10 x 20-in. cylinders gave 96 and 92 per cent of the strength of 6 x 12-in. cylinders.

4. Concrete cylinders having a ratio of length to diameter of from 0.5 to 4.0 gave the following average strength-ratios at 28 days:

Ratio of length to diameter	0.5	1.0	1.25	1.5	2.0	3.0	4.0
Strength-ratio, percentage of strength of 6 x 12-in. cylinder	178	115	107	103	100	95	90

In general, these strength-ratios agree with those reported by other investigators. The difference in lengths of cylinders having ratios of length to diameter between 1.5 and 2.5 was not important.

5. The 6- and 8-in. cubes tested at ages of 7 days to 1 year gave strengths averaging 13 and 15 per cent higher than 6 x 12-in. cylinders. The strengths for 6 x 12 and 8 x 16-in. prisms were lower at all ages than that for 6 x 12-in. cylinders; the strength-ratios averaged 93 and 91 per cent, respectively.

6. For all forms of specimens the compressive strength increased with age for moist curing. For cylinders and prisms of length equal to twice the diameter or width, the 7-day, 3-month and 1-year strengths averaged 52, 142 and 178 per cent of the 28-day strength for 1 : 5 concrete. The corresponding percentages for 6- and 8-in. cubes were 60, 129 and 165 per cent.

* * *

Cement Requirements for Modern Highway Construction

By A. T. Goldbeck
Chief, Division of Tests, U. S. Bureau of Public Roads

Is it possible that the standard requirements for portland cement should be altered to produce a cement more suitable for pavement construction than the portland cement now available under our present specifications? Is it possible that the particular demands made on concrete pavements render it advisable to use a particular quality of cement having properties not possessed by our present portland cement and, if so, is it likely that economy will result from the use of this special cement?

Service Requirements — That we might have a better understanding of the qualifications of portland cement for pavement construction it will be well to review very briefly the various influences to which concrete pavements are subjected, tending toward their gradual deterioration, for too frequently the fact has been overlooked that concrete highways are subjected to many forces other than traffic loads.

When the wet concrete is placed on the subgrade, unless the proper precautions have been taken to insure against rapid absorption of water by the subgrade or against rapid evaporation of moisture from the surface of the concrete, shrinkage begins and cracking or crazing might result immediately. The unequal swelling of the subgrade might produce local bending of the setting concrete with the production of high tensile stresses at a time when the concrete

has practically no resistance to tension. If the concrete is kept moist during its initial curing period its slight expansion due to moisture will result in a small and harmless compressive stress, although all too frequently contraction begins even in this initial stage due to insufficient moisture. During the curing period there will be daily fluctuations in temperature resulting in expansion during the day with the production of compressive stress and in shrinkage at night with the production of direct longitudinal tension. At the end of ten or fifteen days when the usual curing period has ended, the concrete is allowed to dry and it shrinks with the production of tensile stress due to the frictional resistance of the subgrade. Sufficient longitudinal tension might be produced to form transverse cracks at frequent intervals. Such transverse cracks are inevitable unless they are built into the pavement through frequently spaced expansion or construction joints.

In the meantime, during the day, the sun heats the top surface of the concrete thereby expanding it, while the bottom surface remains at a more uniform temperature. The effect necessarily is to warp the pavement slab, cause it to bear on the subgrade at the corners and edges and to rise somewhat along the center. At night the reverse is true, the top surface contracts and the bottom surface remains more stationary. The corners and edges now rise and in many cases actually leave the subgrade. High bending stresses are thus again produced and every day the pavement goes through this cycle of bending. During long-continued periods of wet weather the concrete takes up moisture and expands, and when this expansion is combined with the expansion due to high temperature, the concrete is subjected to high compressive stress longitudinally, so-called "blow-ups" sometimes take place and the pavement heaves in spots away from the subgrade. This phenomenon is especially prevalent in the spring of the year, for this time is favorable to the combined expanding effect of high moisture content and high temperature. The action of freezing on concrete pavements should not be overlooked. Such action is especially noticeable where improper materials or construction methods have been used and it results in the scaling of the surface. The influence of the quality of the cement in causing scaling is in need of investigation.

Under traffic the pavement is subjected to very severe bending stresses and tension occurs both at the top and at the bottom of the slab depending upon the position of the load. Concrete is not particularly strong in tension, its value being only from one-eighth to one-twelfth of its compressive resistance. Bending stresses are to be feared because of this inherent quality of concrete to be weak in tension. It is the practice in most localities to permit traffic on concrete pavements in the very early stages of their hardening when the bending resistance of the concrete is still small.

Higher Strength Concrete—Thus pavements are subjected to a variety of influences which tend to harm them and these influences must be combated by the use of proper materials, proper design and construction methods. In general, the most destructive of these influences are those which produce tensile stresses in the pavement and may be tabulated as follows: (1) Shrinkage of concrete due to drying of moisture; (2) Contraction of concrete due to decrease of temperature; (3) Warping of the slab due to variations in temperature and moisture; (4) Bending due to heavy wheel loads applied frequently; (5) Bending due to non-uniform subgrade support; (6) Excessive compressive stress due to rise in temperature or increase in moisture content or a combination of both; (7) Frost action.

An analysis of the above influences leads us to the conclusion that concrete for highway construction would be even more suitable from a technical standpoint than it is at present: (1) If it developed high tensile strength within a very few days; (2) If it had a very low shrinkage factor under the action of moisture and temperature; (3) If it were even more durable in its long-time resistance to alternations of freezing and thawing, wetting and drying, changes in temperature and repeated loads.

Technically then, concrete having high early tensile strength which would be maintained over a long period of years would be very desirable for concrete pavement construction. Investigations of concrete have shown that strength is very largely dependent on the ratio of volume of water to cement used in the mix and that the so-called "water-cement ratio," assuming a given kind of cement, is the most important factor governing the strength of the concrete. It is logical to infer that the use of a higher strength cement or the use of more cement must likewise lead to higher strength concrete. Several ways are thus open to the engineers who are seeking concrete of higher strength, such as drier consistency, more cement, better aggregates both in quality and gradation and finally higher-strength cement.

In the light of the previously discussed desirable properties for highway concrete let us inquire into our present standard test requirements for portland cement, so far as that seems possible, to see to what extent they insure the production of cement which will make satisfactory and economical highways.

Fineness—The specifications require that not more than 22 per cent residue shall be retained on a standard No. 200 sieve. The question arises whether or not it would be desirable to require the use of a finer cement. It has been shown in connection with the work of the Joint Conference on Uniform Methods of Tests and Standard Specifications for Cement, in a report published by Committee C-1 of the American Society for Testing Materials dated July, 1919, that there is only a slight increase in the strength of portland cement with increased fineness, and also a slight increase in the crushing strength of concrete. Thus, 1 per cent reduction in the residue on the No. 200 sieve resulted in about 1.3 per cent increase in the crushing strength of 1:2:4 concrete at 28 days. No figures seem to be available on the effect on the tensile strength or resistance to bending.

Whether the extra cost of finer grinding is justified by the slightly higher strength obtained in the concrete does not seem to be established. Information is also needed on this point. Information is also needed on the effect of fine grinding on the durability of the concrete. The effect of fineness on deterioration in storage is also to be considered.

Soundness Test—It is a question whether the soundness test as now made is really suitable for bringing to light the qualities undesirable in cement from the standpoint of highway construction. A quantitative test for soundness of cement should be investigated to indicate degrees of unsoundness.

High shrinkage of concrete is undoubtedly due largely to the shrinkage of the cement and it is recognized that different cements shrink and expand differently with moisture changes. Some quantitative test of the volume change of cement might be desirable for judging of its value for concrete road construction.

Tensile Strength—It would seem that unquestionably the tensile strength of cement must influence the strength of the concrete in tension and cross-bending, and it would seem also that cements having the highest tensile strength should be more suitable for highway concrete than those of low strength. Technically, high early tensile strength is to be desired, provided the strength will not decrease with age.

It is recognized of course that other factors influence the concrete strength even more than the variation in the strength of the cement. While the available test results are not entirely concordant in showing increased concrete strength with increased strength in portland cement as now tested in the form of 1:3 mortar briquets, the trend is certainly in that direction and this trend is well illustrated by tests with high-alumina and other special cements. In certain localities it would be quite practicable to raise the test limits for tensile strength without inflicting any hardship on the manufacturers and without causing them to change their methods of manufacture or the characteristics of their output. In a very few instances, on the other hand, an increase in the tensile strength requirements would be difficult to meet and, in fact, would bar the product of certain mills. Here again, the technical features of the specifications must be considered in conjunction with the economics of the resulting concrete in the highway.

Highway engineers would welcome cement of higher tensile strength, especially in the early period of hardening provided durability and economy are not sacrificed. Highway engineers would also welcome a strength test that could be made after a few days instead of seven days and they would like a refinement in the tensile test which will eliminate the wide variations in test results which are now possible. A reversion to the neat test has been suggested. Let it be remembered that we are concerned with the mortar and concrete-making properties of cement and that fineness

of grinding has a different effect on the neat and mortar strengths.

Time of Set—The setting time of portland cement under certain conditions might well be regulated so that the concrete would set up faster than at present. At times it is difficult to maintain a smooth finish on a concrete road owing to the slumping of the concrete down grade after it has been finished. A quicker setting cement for this purpose would be desirable and, of course, a quick setting cement would be desirable for cold-weather conditions. Cement complying with the low limits of the specifications, however, should be satisfactory for the above conditions but otherwise the present test limits for time of set are suitable for concrete road construction. Instances are recorded of cements passing the Gillmore test and failing in the Vicat test. We should not be satisfied with our present methods of testing for time of setting. They need more careful control.

It is not felt that any of the other tests for portland cement need discussion as to use for concrete pavements.

Opinions of State Highway Testing Engineers—The following questions were asked of a number of leading highway engineers:

(1) Specifically, have you information showing whether or not cement which just passes the specifications will or will not make good concrete?

(2) Have you any test results co-ordinating the tests on cement with the strength of concrete made from various brands of cement having various physical properties?

(3) Have you any definite ideas as to whether or not the portland cement requirements should be made more severe?

In brief, the answers to the first two questions revealed very little information. There are some test results showing higher-strength concrete with higher-strength cement, but there seems to be no definite information on the value of concrete made with cement just passing the present standard requirements. Of the thirty engineers replying to the third question, ten were in favor of making the tensile strength limits more severe because they thought that a better quality of concrete would result while the remaining twenty did not advocate changing the present standard specification. Several of the state engineers were dissatisfied with the reliability of the soundness test, others believed finer grinding desirable. The advisability of a strength test which could be made in a few days was also stressed.

Conclusions—Very satisfactory concrete roads have been built with cement passing our present standard requirements. As a rule, however, most brands of cement fall well within our minimum test limits and some doubt has been expressed whether low testing cement is really satisfactory for concrete pavements because of the high early stresses to which pavements are subjected. It would seem that technically high early testing cement should lead to still better construction. Economically this has yet to be demonstrated. If high early strength can be attained with no decided increase in cost and no danger of disintegration, surely it is justified and desirable and is something which cement manufacturers should look forward to. It is felt that in many cases where cement is testing low, the mill practice is at fault and much better results would be possible if such mills would exercise more meticulous control over their product. There is no question in my mind that the general standard of quality of portland cement can be raised merely through careful manufacture on the part of all of the mills instead of in some of them.

Highway engineers are anxious to secure concrete of high early strength and great durability. In general, they recognize that several ways lead to this end, one of which is the use of cement even more suitable than at present available. Perhaps their goal may be reached by the use of higher quality cements. That is well worth investigating but the making of concrete highways is costing vast sums and technical questions are not alone involved. Caution is necessary that too hasty action be not taken before the full facts have been demonstrated. Several organizations and committees are at work in an effort to improve the quality of cement, the methods of testing cement, and the specifications for its control.

So to manufacturers I would say there is a growing feeling that a higher quality of cement is desired and that some manufacturers at least can and should improve their product for highway construction.

To highway engineers my message would be that they are justified in their attempt to obtain concrete of higher tensile or crossbending strength, but the means adopted, whether better cement, more cement, or better concrete control, should be based on established facts and it should be remembered that economic as well as technical questions are involved.

* * *

Bond Between Concrete and Steel

By Duff A. Abrams

Professor in Charge, Structural Materials Research Laboratory, Lewis Institute, Chicago

THE investigation described in this paper was undertaken for the purpose of determining the relation between bond and the factors which are known to govern the compressive strength of concrete. Bond tests were made by applying a pull on one end of 1-in. plain round steel bars embedded axially in 8 x 8-in. concrete cylinders. The concrete covered a wide range in size and grading of aggregate, quantity of mixing water and cement, and was tested at ages from 7 days to 1 year. Hydrated lime and crude oil were used as admixtures in a few tests. There were 735 pull-out bond tests, and 735 parallel compression tests on 6 x 12-in. cylinders.

The data presented show the load-slip relations for pull-out tests; the relation between bond and compressive strength; the effect of grading of aggregate, quantity of cement, consistency of concrete and age at test, upon the bond and compressive strength; and the effect upon the bond of oil and hydrated lime as an admixture.

The data indicate that the use of 4 per cent of the 28-day compressive strength of concrete as working stress in bond for plain bars as specified by the Joint Committee on Standard Specifications for Concrete and Reinforced Concrete, is justified, giving a factor of safety of 2½ to 3 against slip.

Following are the principal conclusions:

1. A steel bar embedded in concrete offers considerable resistance to a pull-out load. Slipping of the bar begins at a bond stress of about 10 to 15 per cent of the compressive strength of the concrete, but considerable additional load is taken before the ultimate bond resistance is reached. For pull-out tests of the type used, 0.0005 in. end slip of bar occurred at 55 to 60 per cent of the maximum bond; for mixture lower than 1:1, the maximum bond was about 24 per cent of the compressive strength of the concrete and came at an end slip of about 0.01 in.

2. Bond and compressive strength increased with age of the concrete from 7 days to 1 year. For 1 : 5 concrete of water-ratio 0.88, the bond at 1 year was 134 per cent of the 28-day value and compressive strength 148 per cent.

3. Bond responded to changes in water-ratio of the concrete in much the same way as compressive strength; increase in water-ratio due to use of wetter concrete, less cement, or an excess of fine aggregate, resulted in material reductions in both bond and compressive strength. Other tests have shown that the same statement applies to the modulus of elasticity of concrete, impermeability, resistance to wear and resistance to destructive agencies such as weather, sea and sulphate waters, etc.

4. For mixtures richer than 1 : 1, the bond fell off, probably due to the greater volume changes during hardening, which is characteristic of such mixtures.

5. The use of 4 per cent of the 28-day compressive strength of concrete as the working stress in bond for plain bars, as specified by the Joint Committee, is justified; this gives a factor of safety of about 2½ to 3 against first slip.

6. The use of crude oil to replace mixing water, in general, caused a reduction in both bond and compressive strength of concrete. Five per cent of oil reduced bond at 28 days about 20 per cent; at 1 year, about 6 per cent; compressive strength at 28 days and 1 year was reduced about 3 per cent.

7. Replacing cement with hydrated lime decreased the compressive strength and bond about 1.2 per cent for each 1 per cent of hydrated lime in terms of volume of cement or about 2.0 per cent for each 1 per cent by weight.

[This conclusion was questioned by W. A. Slater (U. S. Bureau of Standards) and E. B. Smith (U. S. Bureau of Public Roads) who contended that the figures presented in the paper warranted these conclusions only for higher replacement percentages of hydrated lime than are commonly used.]

8. The pull-out test of the form used in this investigation shows the form of specimen satisfactory for studies of bond.

Cantilever Balcony Framing For Special Conditions

Difficulties Arising From Demands of Balcony Architecture—Some Cases of Shallow and Bent Girders

By David C. Coyle
Structural Engineer, Gunvald Aus Co., New York

THE necessities due to architectural limitations are particularly likely to bring forth inventions when the subject in hand is a balcony for an auditorium. There seems to be a canon of architecture that balconies must be like the punishments forbidden by our constitution, "cruel and unusual." The accompanying sections show some of the conditions which had to be met in one recent case.

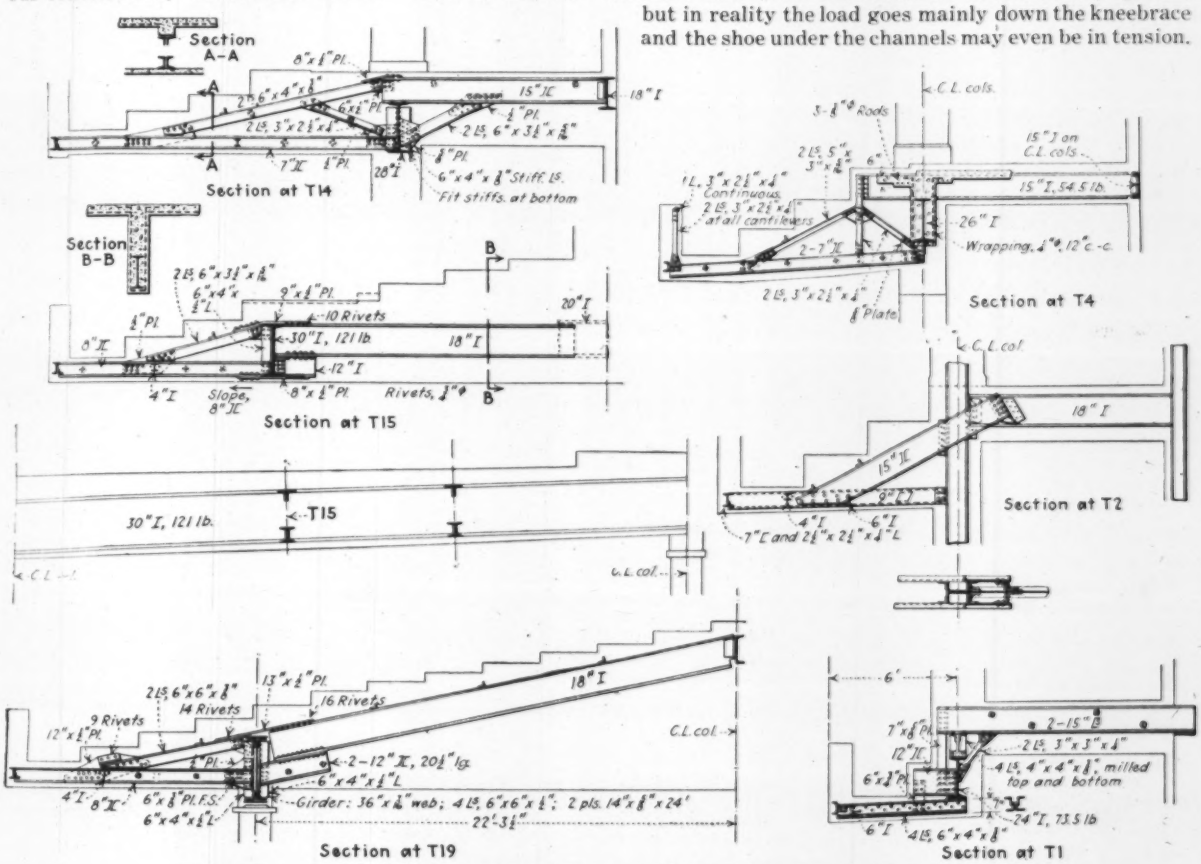
In section T1 the cantilever section is vertical at its point of greatest constriction; what is required is a Z-shaped beam. The kneebrace is redundant.

Section T2 requires a bent beam with a heavy bending stress. Owing to the shortness of the tail the design had an appearance of insecurity, which was remedied by extending the 9-in. channels back to the face of the column from their point of support on the end of the sloping cantilever. This also eliminates the twist at the latter point.

Section T4 is an economical and strong design solving a rather difficult problem. It gives an optical illusion which produces the impression that there is a horizontal kick at the bottom of the 26-in. I. Even after demonstration with a model and rational proof that the reactions are all vertical the illusion persists.

Section T14 is a rather flattened form of the usual gallery cantilever, and T15, T19 are variants where the flattening is so severe that the kneebrace is crowded out. Note in T19 that the tension plate does not touch the girder; the vertical reaction is all carried by the two 12-in. channels and the small gusset at the top on the outer side.

This calls attention to another optical illusion, which occurs when the top chord of a cantilever is a pair of channels which passes unbroken over the top of the girder and with a kneebrace forms the tail. It looks in such case as if the channels rested on the girder, but in reality the load goes mainly down the kneebrace and the shoe under the channels may even be in tension.



SOME SPECIAL PROBLEMS IN CANTILEVER BALCONY GIRDER CONSTRUCTION

So also in T14 the reaction between the 15-in. channels and the 28-in. I is probably negative for most conditions of loading.

These sections are submitted in the hope that they will serve as suggestions to some harried engineer beset with the imperious demands of Art.

New Sewage Sludge Boat for Glasgow

A sewage-sludge twin-screw steamer for Glasgow, Scotland, with a capacity of 1,400 long tons, was recently launched. The boat is 260 ft. long, 42 ft. broad, 16 ft. deep, has a speed of 11 knots, with triple-expansion engines of 1,200 i.hp., and is said to be larger and more powerful than boats for like use built for Liverpool, Salford and other cities.

Earthquake Damage to Santa Barbara Buildings

Committee of Engineers Surveys Damaged Structures—Poor Design and Workmanship Responsible for Much of the Heavy Damage—No Steel Frame Buildings — Conclusions About Earthquake Effects

BY HENRY D. DEWELL
Consulting Structural Engineer,
San Francisco, Calif.

THE EARTHQUAKE that rocked Santa Barbara, Calif., on June 29 continued intermittently for a period of 24 hours, though the heavy shocks that caused most of the damage all occurred within an hour after the first, at 6:40 a.m. The fact that there were only thirteen persons killed and fifty injured was doubtless due to the small number of people that were at this hour in the business section, where the heaviest damage occurred.

A feature of the disaster was that literally before the dust had cleared away offers of engineering assistance from San Francisco had been accepted and when the engineers arrived they were given absolute authority. Practically all organization of inspection and reconstruction work was perfected with speed and efficiency under their direction and in co-operation with the city manager, Herbert Nunn, who is also an engineer. Unlike other disasters of the kind, this one had neither fire nor dynamite to cover the effects of the quake on structures. This afforded an unusual opportunity for observation.

FIG. 1—SANTA BARBARA'S MAIN THOROUGHFARE, STATE STREET
Because of the fire risk, prompt action was taken to clear streets. All thoroughfares were partly cleared and open six hours after the quake.

Strong Local Earthquake—Dr. Bailey Willis of Stanford University, president of the Seismological Society of America and a recognized authority on earthquakes, was in the suburbs of Santa Barbara at the time of the earthquake. He classifies the Santa Barbara earthquake as a local shock of moderate severity and has stated that it should be rated between 8 and 9 on the Rossi-Forel scale; probably nearer to 8 than 9. (In this scale, which is a standard among seismologists, the following classification is used: 8—very strong shock, fall of chimneys, cracks in walls of buildings; 9—extremely strong shock, partial or total destruction of some buildings; 10—shock of extreme intensity, great disaster, buildings ruined, disturbance of the strata, fissures in the ground, rock falls from the mountains.) For comparison it may be stated that the San Francisco earthquake of 1906 was between 9 and 10 on the same scale. In making a comparison of the intensity of the two earthquakes it is to be noted that the scale increases in logarithmic ratio. The origin of the shock was very near the surface, Dr. Willis says, the fault line being in the Santa Ynez Mountains. The length of fault affected extended approximately from Ventura to Gaviota and passed directly through the Sheffield reservoir, whose dam failed.

Engineers' Committee Makes Structural Survey—Immediately after the quake the city council, the president of the Chamber of Commerce and the mayor organized a board of control vested with power to act. When the engineers sent by San Francisco arrived the board placed upon them authority to organize and proceed with a survey and appraisal of damage in the business section and to decide finally what buildings should be completely destroyed. This structural survey was under the general direction of C. D. Marx, chairman of the visiting engineers, assisted by C. B. Wing, C. E. Grunsky and the writer. The writer went to Santa Barbara at the request of *Engineering News-Record* and was there drafted into service on the committee.

This committee at once divided the business district into six divisions, with a seventh comprising the principal structures in the outlying districts, and divided inspection work in each district among the members. After an intensive two-day survey the final report was submitted to the board of control on the night of July 2. Statements in this article are based partly on the report of this committee. In those cases in which immediate demolishing of structures was recommended the engineers' committee appointed Professor Wing and the writer as a special committee to give these a second examination in order to make sure that demolition was necessary.

Water and Sewer Conditions—The breaking of Sheffield reservoir flooded the lower part of the city with the 45,000,000 gal. of water released. Three smaller reservoirs, however, remained intact, as did the 4½-mile tunnel and the Gibraltar dam which stores the city's water supply on the Santa Ynez River above the upper end of the tunnel. By 10 o'clock on the morning of the quake all mains were repaired or bypassed, and by noon also the sewers. Small fires were extinguished

immediately and steamers at the municipal pier were prepared to pump salt water in case the water supply should be cut off by further shocks.

General Building Conditions Poor

The business district of Santa Barbara extends along State St. for a length of about 5,000 ft. and covers a width of about two blocks, an area of about 114.78 acres. Outside of this district there are scattered throughout the city various important structures (hospitals, schools, an orphanage, etc.), generally of reinforced concrete. Prior to the earthquake there was no modern building law in Santa Barbara and apparently no competent supervision of construction. A modern building law, however, is now being put into effect. The general type of structures outside the business district is what is commonly known as Class C, consisting of masonry walls of brick or hollow tile and timber interiors, usually only one or two stories in height.

FIG. 2—BRICK-AND-WOOD CONSTRUCTION SHAKEN TO PIECES IN HOTEL CALIFORNIAN

As far as could be determined there are no buildings in Santa Barbara with structural-steel frames. The most modern business buildings were built of reinforced concrete, some with reinforced-concrete walls and others with curtain walls of brick and hollow tile. Hollow tile was used very extensively, particularly for the walls of one-story structures and the interior partitions. The quality of materials and workmanship throughout the older structures was poor, noticeably so in the brick masonry, which undoubtedly explains the general collapse of such structures.

Some reinforced-concrete structures withstood the shock well and others were badly damaged. The difference may be ascribed in part to soil conditions and foundations, but chiefly to design and quality of materials and construction. Unfortunately the absence of steel-frame buildings prevents a comparison of steel with concrete construction. The writer's impression is that a properly designed structural-steel frame would have suffered no damage in this earthquake. Those buildings of reinforced concrete which seemed to be properly designed and well tied together with reinforced-concrete walls and with proper attention to bracing suffered very little damage. On the other hand, those buildings — and there are a number of them in Santa Barbara — which were constructed with a light reinforced-concrete frame and which apparently had no attention given to bracing for resistance of lateral forces suffered severely. Hollow tile proved, beyond question, to be unsuited to resist earthquakes. Hollow-tile walls and partitions, generally were a complete loss.

Reinforced-Concrete Frames

The Central National Bank building is a 6-story structure estimated to have cost around $300,000. This building has a reinforced-concrete frame with tile curtain walls and partitions. As a result of the quake the side wall is very badly cracked in the lower stories. The State St. front is apparently undamaged, showing the direction of the earthquake forces. The report of the engineer who made a survey of this building estimated the damage to be approximately $150,000.

FIG. 3—LIGHT REINFORCED-CONCRETE FRAME WITH HOLLOW BRICK WALLS, ARLINGTON HOTEL

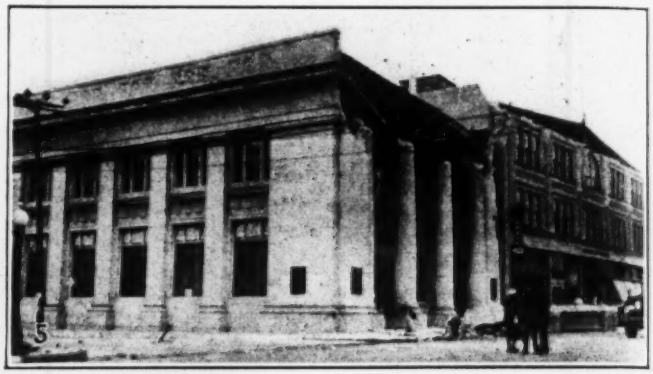
The San Marcos Building, a reinforced-concrete structure 4 stories high, was perhaps the most spec-

tacular failure. It illustrates the writer's comment on reinforced-concrete structures. This building is in the shape of an L, fronting on two streets; the corner portion collapsed entirely and the portions that remained standing were very badly damaged. All interior partitions of this building were of hollow tile and there was no bracing whatever. The floors were of arch-and-joist construction; the quality of the concrete as judged by inspection was poor.

Destruction of Tile Walls—The St. Francis Hospital, a building approximately 60x250 ft. in plan and four stories high, is another illustration of the inadequacy of a light reinforced-concrete frame and hollow-tile walls and partitions. This building is mentioned particularly because the writer had the opportunity of examining it in detail. With the exception of the top story outside walls, the hollow-tile walls were practically demolished. The reinforced-concrete frame suffered very severely, particularly in the first and second-story columns. Practically all of these columns were crushed where the top of columns joined the bottom of the second-story beams, and in some cases these columns were completely sheared and pushed out. It would appear to the writer that this building is probably a total loss, although it is barely possible that some scheme may be evolved for rebuilding the lower story columns and bracing the building by means of reinforced-concrete walls.

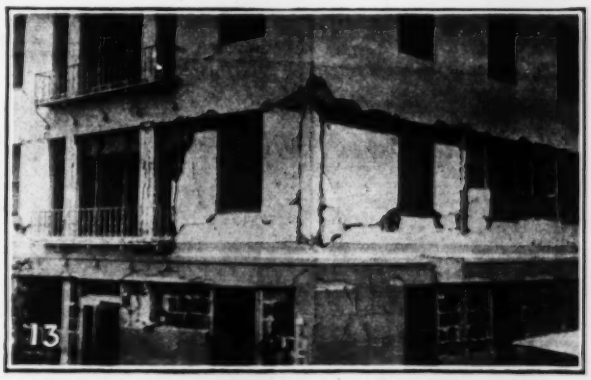
Bending Failure of Columns—It is well known to structural engineers acquainted with earthquakes that shocks of this nature exert a lateral force upon the structure, causing bending as well as shear in the columns, the maximum bending occurring at the junction of columns and girders in the first and second stories, and being particularly severe at the junction of the first-story columns with the second-floor girders. In all the frames examined at Santa Barbara the effect of this bending was very marked, as evidenced by the crushing of the concrete at the top of the first-story columns. In some cases the steel rods in the columns were buckled, and in many cases reinforcing was exposed at this point. It may also be mentioned that the direction from which the shock came was shown clearly by the location of the damage in the columns and walls. The conclusion is obvious in these cases—that no attention had been given in the design to resistance against lateral forces since the columns, being much weaker in bending than the beams, suffered the greater damage. No fillets or gussets were used.

Inadequate and improper design used in many cases, particularly in the older structures, is well illustrated by the Arlington Hotel. This structure has a reinforced-concrete frame. The walls are of brick, and until the earthquake revealed the true structure were apparently of massive construction. Actually these walls were hollow, the exterior and interior faces being of brick 4 in. thick and not tied in to the structural frame. In other words, the buttresses, pylons and other ornamental features of massive appearance were mere shells, not even tied to the reinforced-concrete frame.



FIGS. 4 TO 7—BUILDINGS WITHOUT STRUCTURAL FRAMEWORK IN SANTA BARBARA EARTHQUAKE

Fig. 4—Mission Santa Barbara—heavy masonry.
Fig. 5—First National Bank Building—brick walls and timber roof.
Fig. 6—City sewage pumping station—hollow tile walls, steel roof trusses, slab foundation. On filled ground.
Fig. 7—Potter Theater—stage completely wrecked.



FIGS. 8 TO 15—REINFORCED-CONCRETE-FRAME STRUCTURES THAT SUFFERED DAMAGE

Fig. 8—San Marcos Building—Corner portion (early construction) destroyed, wings still standing.

Fig. 9—San Marcos Building, end portion—The wings are badly damaged. Many columns are shattered.

Fig. 10—Central part of Arlington Hotel—Concrete frame with hollow brick walls.

Fig. 11—Typical construction in Arlington Hotel—Concrete columns inside of hollow brick wall.

Fig. 12—Central Bank Building—Reinforced-concrete frame, tile walls.

Fig. 13—St. Francis Hospital—Second-story corner column shattered at junction with floorbeam.

Fig. 14—Masonic Temple—Front wall columns buckled.

Fig. 15—Junction of beam and column in Arlington Hotel.

The result, as might be expected, was a general demolition of these walls in the lower stories.

Well-Designed Buildings Undamaged

Typical of the reinforced-concrete buildings which successfully withstood the earthquake are the Granada Theatre, a theatre and office building six stories in height; the Lobero Theatre; the St. Vincent Orphanage; the Cottage Hospital; the State Normal School; the new high school, and several other similar structures. These structures effectively resisted the earthquake shock and suffered no material damage, apparently because they were well designed, well tied together with cross walls of reinforced concrete, and of good materials and workmanship.

From the writer's observation of the Cottage Hospital, the St. Vincent Orphanage and the new reinforced-concrete portion of St. Anthony's College, reinforced concrete when properly designed and constructed is well suited to buildings of this nature in earthquake zones. That is, buildings only two or three stories high, whose general layout permits of cross walls at frequent intervals, are well adapted to resisting earthquake shocks and are economical, costing usually not more than ordinary Class C construction.

The method of repair in those reinforced-concrete structures which have suffered but slight damage—for example, when a few of the first-story columns have been crushed at their junction with the second-floor beams—is a problem which warrants careful consideration. Obviously all of the damaged concrete must be removed. If the reinforcement has not been distorted or bent out of place it is possible that after the damaged concrete has been removed the column may be built up to its original shape with rich concrete and that it will then be able to function as well as before. After that had been done, however, the writer feels that the finished product would not be as satisfactory as new construction. In this respect the structural-steel frame has a great advantage because where a structural-steel frame is damaged at the connection by shearing of the rivets, a repair of this damage would restore the connection with certainty to original strength.

Conclusions on Structural Resistance

The following statements summarize the writer's conclusions after the intensive two-day survey of the principal business buildings:

1. The earthquake was of moderate severity.
2. The damage done was largely due to poor construction.
3. Low Class C buildings of good masonry and well constructed withstood the shock well.
4. As far as can be determined there were no buildings in Santa Barbara with a structural-steel frame. Consequently no comparison between reinforced-concrete frames and structural-steel frames can be made.
5. Reinforced concrete of good quality, where it had been used intelligently, came through the shock without showing more than minor damage.
6. Brick construction withstood the shock in proportion to its quality. In most cases, due to the poor construction, brick walls were completely demolished.
7. Hollow tile in general is shown to be entirely inadequate for resistance to earthquakes and is a menace to life.
8. The skeleton frame of reinforced concrete without solid reinforced-concrete walls, and without adequate bracing against lateral forces is not suited for resistance to earthquakes.

Estimated Damage—Estimates of structural damage alone in the business district as summed up on the evening of July 2 indicated that the total would be somewhere between $10,000,000 and $15,000,000. Santa Barbara is now working out a reconstruction program under which a loan of $20,000,000 is being floated to cover the reconstruction and new construction essential to restoring the city to the extent required by present needs.

Hydraulic Turbine of New Design Developed in England

A Waterwheel Having Some Special Features and Suitable for Low Head Settings and Small Hydro-Electric Units

By F. Johnstone-Taylor
Fidlers Ferry, Warrington, England

THE BANKI TURBINE which has been undergoing development in England in recent years differs considerably from the orthodox type of hydraulic turbine. It is intended for the development of small quantities of power at low-head, low-flow sites and to provide a high-speed unit of simple design for operating small generators. With this turbine, even under very low heads a relatively high speed is obtainable. The foundations and other incidental works are of the simplest and no building is normally required to house the turbine which when placed in a simple raceway works quite well even when completely drowned by the tail water.

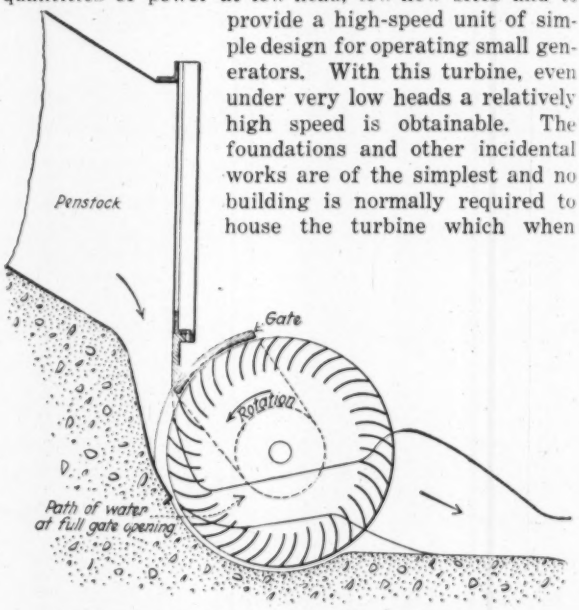


FIG. 1—SIMPLE SETTING FOR LOW HEADS

It will be observed from Fig. 1 that the wheel itself bears a marked resemblance to the old Poncelet waterwheel. The latter, however, in common with other such wheels had by reason of its construction a low efficiency. The Banki turbine with its vanes quite open at the back permits the water to pass through the buckets across the open center portion of the wheel and to make a second passage through the buckets on the opposite side in a reverse direction. At each pass the water is deflected and gives up its energy, eddies and shocks are avoided and the water issues quietly into the tail race. This is clearly shown by Fig. 1, which depicts

the actual path of the water across the wheel under normal full load conditions. The tail water, it will be observed, stands up to near the center line of the wheel. This is the setting which gives the best results although, as stated above, the wheel will work without a loss of efficiency of more than 10 per cent when completely drowned.

Turbines of this class are therefore ideal for replacing old waterwheels and small out-of-date vertical-shaft turbines with the minimum of expense. They are

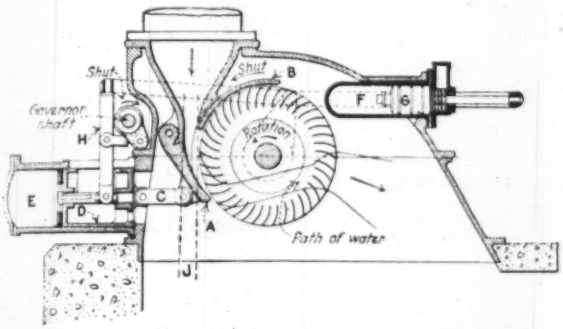


FIG. 2—SETTING FOR MODERATELY HIGH HEADS

capable of operating under the very lowest heads, and in situations where a governor is not deemed necessary the whole arrangement, as shown by Fig. 1, is very simple and inexpensive. The supply of the water by a short penstock is an arrangement intended to apply to falls of 10 ft. or so. For very low falls the turbine would simply be set in an open flume while for certain other conditions the water might, as shown presently, be supplied by a pipe line.

Governing—Apart from the simple unit without governing gear as shown in Fig. 1 the type is quite capable of being closely governed. The method adopted is that of a deflector which, coming into immediate action on the falling off of the load, diverts the course of the water. The regulating gate is then slowly closed the requisite amount and the deflector comes back into its normal position ready for action when required. The system is in fact practically identical with the needle-cum-deflector system used to a large extent by European Pelton wheel builders; the gate in the case of the Banki turbine taking the place of the needle. This is more clearly shown in Fig. 2, which is an arrangement suited to heads of 60 ft. or so. The mounting is very similar to that of a Pelton. Assuming the load to be thrown off the machine, the governor swings back the hinged nozzle piece *A* allowing the water to escape without striking the wheel. At the same time the steel regulating gate *B* is slowly closed, cutting off the flow of water while the hinged nozzle piece *A* is gradually brought back to its normal position. Close speed regulation is thereby obtained without any risk of shock in the pipe line. The Banki turbine can therefore be classed as a small hydro-electric unit which shows to some advantage. In cases, for instance, where the head is considered too high for a Francis turbine and yet too low to secure a high speed with a Pelton the relatively high speed of the Banki at moderate heads permits of the most economical speed for a direct-coupled generator.

By reference to Fig. 2 it will be seen that gate *A* is attached to the operating piston *D* by a link *C*. Water admitted into cylinder *E* will move the piston to the right and keep the gate *A* closed, the supply then passing through the turbine. Oil pressure admitted by the governor to *F* will move piston *G* to the right and, by means of lever *H*, piston *D* is moved to the left forcing water out of cylinder *E* and opening gate *A*. The sliding gate *B* is also operated by the governor linkwork but by the introduction of a compensating arrangement which follows the usual practice it has a slower motion than gate *A*. The duty of gate *A* is to slow down the turbine rapidly by allowing a free flow to the water as shown by the position of the jet *J* and so give time for gate *B* to close up slowly and so avoid shock. Thereafter *A* returns to its normal position in precisely the same manner as the deflector of a Pelton wheel returns to its normal position after the needle has reduced the jet to its required size.

State Financing of Land Reclamation in Wyoming

STATE loans have been made by Wyoming to 12 drainage or irrigation districts since the passage of a state financing law by the 1923 legislature. Of these, 11 are drainage districts, with a total irrigable acreage of 48,000 acres, on which the average amount loaned was $32.46; while one was an irrigation district, of 11,000 acres, to which a loan of $12.55 per acre was made. Most of the need for state financing has in the past developed in connection with the need for drainage of operating irrigation projects.

As stated in the biennial report of the state engineer (Frank C. Emerson), just issued, land owners find that reclamation of their holdings is twice required, first by supplying water and thereafter by draining the surplus. Mr. Emerson says "The cost of drainage works is such that it is necessary to sell bonds to provide adequate funds. When these bonds are sold through the usual bond houses, the districts must not only pay a comparatively high rate of interest, but are also forced to take heavy discounts and short terms of repayment. Early maturities of principal added to the necessary interest payments were found to be too much of a burden for the farmers, and many of them were headed towards bankruptcy. Under the amortized plan adopted by the state, the land owners in the several districts make a payment of 5 per cent of the total amount of the bonds of the district each year during the first five-year period, and thereafter each year make a payment of 6 per cent of the total amount of the issue. The interest rate charged by the state is 5 per cent, and about 38 years are required to retire the entire issue. This plan of financing on the one hand provides the state with a well secured loan, and upon the other hand provides for land owners terms of payment which are found within their means."

Financing of the one irrigation district was made necessary by reason of inadequate prior financing of its canal, which in consequence was in unsatisfactory and hazardous condition, while at the same time the canal association carried bond issues and unsecured loans at high rates of interest. The state's acceptance of an issue of district bonds in the amount of $140,000 allowed the outstanding obligations to be retired and left a margin for placing the canal in proper condition and assuring its safety against failure.

Letters to the Editor

This department aims to be a forum for the discussion of the views of engineers and contractors. The range of interest should be as wide as possible. Contributors are, therefore, asked to make their letters short.

Large Pile Driver for Manila Pier

Sir—We note with interest letter dated May 23 by A. F. Dyer, printed on p. 1031 of your June 18 issue.

Mr. Dyer assumes that the size No. 00 Union pile hammer used on this work was the same machine which we built for the Nova Scotia Construction Company in 1913, but this is not the case as a new size No. 00 Union hammer was supplied by us to the Government of the Philippine Islands on their order of June 27, 1919. The hammer which Mr. Dyer refers to was overhauled and shipped to Manila as an auxiliary.

Hoboken, N. J. UNION IRON WORKS,
June 23, 1925. W. G. SCHALSCHA, Secretary.

Concrete Strength Predictions

Sir—A correction should be made regarding the article on "Scientific Control of Concrete" published in *Engineering News-Record*, May 14, 1925, p. 811.

The curve shown was furnished by the contractor and is intended to show the average of the test results. The equation should not have been on the diagram.

On this job concrete with a strength of 2,000 lb. per sq.in. at 28 days was desired. The desired 7-day strength, 1,040 lb. per sq.in., was figured by use of the equation $S_{28} = S_7 + 30\sqrt{S_7}$. As the job progressed it was found necessary to know the strengths at other ages than 7 and 28 days and a curve was made up showing the probable strength at all ages up to 28 days. This curve was made up from data in the Report of the Committee on Placing Concrete in Winter of the American Railway Bridge and Building Association, October, 1924. If the strength of the test pieces was equal to or greater than this curve the concrete was accepted as having the necessary strength.

The curve showing the average results obtained on the job was used in estimating strength as shown in the table under heading "estimating strengths." The actual strength column is the strength of the concrete in the test piece. The strengths at 7, 28 and 90 days are estimated by using the graph of the test results. This graph was extended as a parabola to 90 days.

GEORGE CONAHEY,
Consulting Engineer,
Manager, Department of Concrete
New York City, Control, E. E. Seelye.
June 23, 1925.

Probability Methods for Rainfall and Runoff

Sir—In *Engineering News-Record*, June 25, 1925, p. 1071, Charles W. Sherman of Metcalf & Eddy advances the opinion that the number of cases in which flood damage may occur is of more significance than the percentage of the years in which floods occur as contended by the writer on p. 906 of the May 28 issue.

From a practical standpoint it would seem that in case the maximum for the season sweeps away the waterway structures or destroys the crops, the damage is done the same as though the submaximums did not exist. On the other hand, if the structures are able to withstand or the crops to survive the seasonal maximum, the submaximums have no terrors for them.

From a theoretical standpoint, time is either a factor or it is not. If time is not a factor, then it is entirely proper to select the actual maximums in the order of size, but it will then be begging the question to claim that the determination of probabilities has anything whatever to do with time. But if time is a factor then each time unit, each annual weather cycle is entitled to representation in the sampling of the data. In fact each such unit must be so represented before the probabilities determination can, in the view of the writer, lay any claim whatever to index chance on the time basis.

There are limitations to all methods and the wise thing is to recognize these limitations in our sampling of data.

Montevideo, Minn., S. L. MOYER,
June 29, 1925. Consulting Engineer.

"Forget You Went to College"

Sir—Permit me to concur in the sentiments and opinions expressed in the editorial, "Forget you went to college," in your June 18 issue. Executives, like the rest of us, want the most possible for their money, or as you say: "the wish to get high-grade labor at low cost is very thinly veiled" and this does not furnish an acceptable point of view when educational methods are under discussion.

I believe the youth, especially the college youth as a whole, that does not dream of reforming the world and ridding it of some of its worst abuses, is as a whole not worth much. The young man does not see the obstacles and the reason for the many social injustices; that is something which experience will teach him. But when he does not even see the injustices and the desirability of reform, but accepts the world as the best possible, there is not much hope for that generation.

I went to Germany in 1899 to study engineering and what impressed me the most was the utter lack of any radical tendencies among the college men. The German government was already the best possible and the thing to do was to let good enough alone, pay your taxes and mind your own business and the government would take care of the rest. And from 1899 to 1914 was only 15 years.

B. F. JAKOBSEN,
Consulting Engineer, Los Angeles County,
Los Angeles, Calif., Flood Control District.
June 25, 1925.

Testing an Arch Dam

Sir—In your issue of June 11, p. 992, H. F. Dunham raises the question of whether there would be an advantage in an increase of radius of the proposed test dam of Engineering Foundation.

By way of information it may be stated that according to the plans as prepared by the Committee on Arch Dam Investigation, the test dam will have an upstream radius of 100 ft. for its entire height. The central angle of the arch at an elevation of 60 ft. above the rock foundation is about 80 deg. If a radius of 400 or 500 ft. were adopted for the test dam, as suggested by Mr. Dunham, the central angle of the dam at the 60-ft. elevation would be less than 20 deg., and at lower elevations still smaller. This would result in extremely flat arches for which the rib-shortening and temperature stresses would be unreasonably high as compared with the axial stresses from water pressure.

A radius of 400 or 500 ft. for a dam of 60-ft. height has not been used in any arch dam so far as I know. On the other hand, quite a few dams have been constructed which in height and length of arch radius compare favorably with the corresponding dimensions of the test dam.

The proposed experiments aim to furnish information on the distribution of stresses in an arch dam for various load and temperature conditions. Information is especially desired on the proportion of water pressure which is supported by horizontal arching and by vertical cantilever and beam action. By tests on the dam and special laboratory experiments, the influence of shrinkage, swelling, lateral deformation (Poisson's ratio), flow of concrete, deformation of bedrock and many other phenomena will be studied.

The studies will supply basic data of benefit in design of futrue arch dams of moderate as well as of long radii. These test results will also be helpful in the design of the arches of multiple arch dams with arch radii of only 20 to 30 ft.

A comprehensive program of the experiments to be made on the test dam has been worked out by the committee. A contract for the excavation for the dam was let recently. The first concrete will be poured as soon as certain special tele-strain gages, which will be embedded in the concrete, are delivered. This will be some time next October. The tests will be carried on for a year or more.

Los Angeles, Calif. FRED A. NOETZLI,
June 29, 1925. Secretary, Committee on Arch Dam Investigation.

News of the Week

CURRENT EVENTS IN THE CIVIL ENGINEERING AND CONTRACTING FIELDS

Building Collapse Kills 43 in Boston

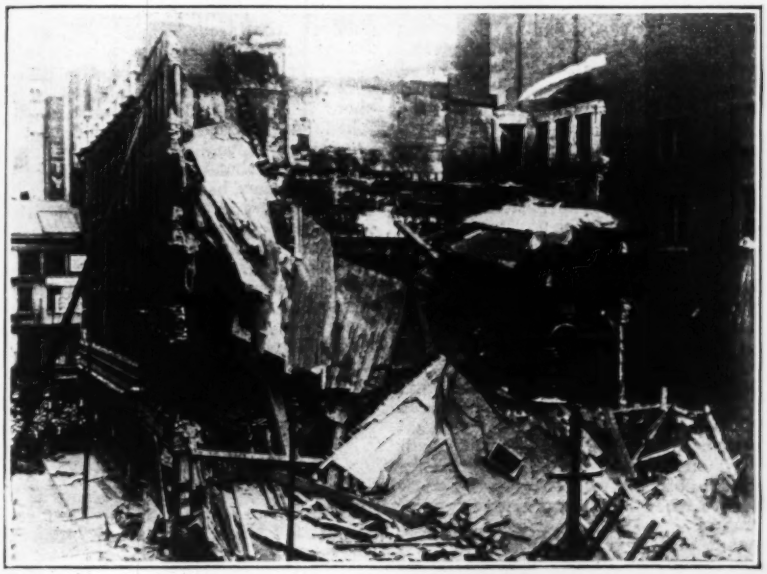
Old Five-Story Brick Building Falls During Dance—Excavation Going On In Adjoining Lot

At about 3:20 on the morning of July 4 while a dance was in progress on the second floor of a five-story building on Beach St., Boston, the building collapsed, killing 43 persons and injuring a number of others.

The collapsed building was a brick structure 45 ft. wide by 65 ft. deep, of the wall-bearing type, with wooden floor joists running parallel to the front. In April a fire damaged the upper stories of the building; the fire damage, estimated at $3,000, was under repair at the time of the collapse. The Pickwick Club, a so-called "night club," occupied the second story of the building. The other floors were untenanted.

Excavations were in progress in the adjoining lot for the purpose of building a garage. The excavations had been carried below the foundation of the building which fell, and these foundations had been underpinned with new concrete footings. The walls were not shored up at the time of the collapse.

The foundation wall facing on the excavation fell down to the level of the bottom of the foundations according to observations made after most of the wreckage was cleared away.



COLLAPSED PICKWICK CLUB BUILDING, BOSTON, MASS.

Two upper floors were undergoing repairs following a fire which occurred in April.

Engineering Fifty Years Ago

From *Engineering News*, July, 1875

Dominion News

THE 5 ft. 6 in. gauge of the Intercolonial Railway was changed last month to the standard 4 ft. 8½ in. gauge. The change was effected over the entire line in one day. The Dominion Government voted $800,000 to carry out the work. The old broad gauge engines, seventy-five in number, would cost $3,000 each to be narrowed down to the new gauge. They will be taken apart and disposed of for what they will bring.

Milwaukee Sewage Disposal Plant Opened

$8,000,000 Activated Sludge Plant for Daily Dry-Weather Flow of 75 Million Gallons

After nearly 12 years of continued effort officials of the Milwaukee (Wis.) Sewerage Commission on June 26 turned the lever of two hydraulic valves permitting sewage to enter the new $8,000,000 activated sludge disposal plant on Jones Island. Mayor Hoan operated one of the 10-in. levers and George P. Miller, chairman of the commission, the other. This is the largest plant of this type yet built and will care for a dry weather flow of 75 m.g.d. collected from the city proper and outlying area in the metropolitan district having a total area of nearly 100,000 acres. An over load of storm water of 50 per cent is provided for. Intercepters, skirting both sides of the Milwaukee, Menominee and Kinnikinic Rivers have been constructed and as fast as bulkheads can be removed the total flow will go to the Jones Island plant. Only 35 m.g.d., about half of the flow, was turned in at this time.

T. Chalkley Hatton, chief engineer, was master of the simple ceremony and then conducted a party of fifty officials and visiting engineers over the plant following the line of sewage through coarse bar screens, grit chambers, rotary fine screens and the activated sludge tanks, (excellently showing up in the newly covered bottoms the construction and the operation of air diffusion through the filtros plates). Sludge will not be accumulated for several weeks so the clarifiers, acidification tanks, sludge filters and drying equipment could not be started. An immense fertilizer storage building more than 500 ft. long to store half a year's production is about half completed. The conveyor system in this

(*Continued on page 77*)

DEBRIS IN EXCAVATION ADJOINING COLLAPSED BUILDING

Foreign Trade Council Holds Successful Convention

The twelfth National Foreign Trade Convention, held in Seattle, Wash., June 24-26, was very gratifying both in point of quality of speakers and number of delegates present. There were 1,440 delegates from 36 states and 70 delegates from various foreign countries.

The convention theme was "Foreign Trade Essential to Prosperity," and all of the speeches, both in the general and group sessions, were based on this hypothesis. Geographic group sessions were inaugurated and proved to be of exceptional interest and value. These sessions primarily emphasized the importance of the countries considered as markets for American goods. The countries considered in separate sessions were: Japan, India, China, Philippines, Mexico, Netherlands, East India and Malaysia, and Canada. The subjects for the other group sessions were: Foreign Trade Credits, Foreign Representation for Export, and Export Problems of Northwestern Producers.

The high lights of the three general sessions were respectively as follows: In the first session, the speech of James A. Farrell, chairman, National Foreign Trade Council, on The Foreign Trade Outlook; in the second session, the speech of Henry M. Robinson, president First National Bank of Los Angeles, on American Banking and World Rehabilitation, and the address by Rear Admiral Leigh C. Palmer, president U. S. Fleet Corp., in the final session on The Government Fleet.

Among the conclusions drawn by several of the speakers was the fact that a merchant marine, under the American flag, privately owned and operated, is essential to the maximum commercial development of the United States. A caution mentioned in several addresses was that investment bankers must continually exercise judgment and foresight in granting foreign loans that may produce unfavorable competitive conditions for American manufacturers. Commercial aviation and its possibilities was another theme of universal interest at the convention. The maintenance of present standards of communication, reduction of taxes, further reciprocity agreements, stabilization of foreign exchange, and reduction of red tape represent other conclusions drawn by various speakers.

River Commission Appointed in Missouri

Governor Baker of Missouri has appointed the following members of the Black and St. Francis River Commission created by the last legislature: James A. Finch, New Madrid, Mo.; W. N. Barron, Poplar Bluff, Mo.; R. B. Hart, Caruthersville; W. F. Shelton, Kennett, and Dr. John F. Wagner, Greenville. The commission will survey the sunken lands in southeast Missouri in the Black and St. Francis river basins with a view of obtaining Federal aid for financing reclamation projects. It will co-operate with a similar commission to be appointed by Arkansas.

New York Starts Surveys for Tri-Borough Bridge

Survey work was recently started for the Tri-Borough Bridge, a long viaduct to connect the boroughs of Queens, Bronx, and Manhattan, New York City. As now planned it is located alongside and roughly parallel to the famous Hell Gate Bridge and viaduct of the New York Connecting R.R., and connects with the Bronx at the foot of St. Anne's Ave., with Manhattan at the east end of 125th St., and with the Astoria section of Long Island City at Potter Ave. It would cross Ward's Island and Randall's Island, and have bridges over the Bronx Kills, the Harlem River, Little Hell Gate, and Hell Gate, the latter to be a high-level span of about 1,000 ft. The city has not yet decided that the bridge shall be built, but has authorized the expenditure of $17,000 for surveys and planning.

Fraud Case Against Fuller Company Fails

On June 15 John C. Pollock, judge of the U. S. District Court for the first district of Kansas, sustained the demurrer of the George A. Fuller Co. to the indictment made against it by the Department of Justice that fraud had been exercised in the construction of the cantonment at Fort Riley, Kansas. The court sustained demurrers to each of four counts included in the third amended petition, previous indictments having failed because the complaint did not particularize the crime charged.

The third amended petition of the government against the Fuller company contained four alleged causes of action: Count 1 in tort for negligence; count 2 for breach of written contract; count 3 a tort for fraud and deceit; and count 4 as quasi contract but really for an overpayment by the government to the contractor in the construction of Camp Funston. Judge Pollock decided that the only one of these four counts which could be considered at all was that charging breach of contract. Were it shown specifically that the contractor had breached the contract recovery could be made by the government after a court of equity had set aside the settlement already made willingly by the government. The whole case, Judge Pollock therefore found, rested upon whether the complaint cited issuable facts of such particularity that the charge of fraud could be proven. This the court found to be not the case. The pertinent part of the decision follows:

". . . after a careful reading of this count, it is seen to contain a mere statement of glittering generalities and conclusions of the pleader. It does charge defendant failed properly to organize its employees or to use due care to superintend and supervise the doing of the work, etc. What a correct standard of supervision or organization would have been is not attempted to be stated. . . . the pleading is not a statement of issuable facts but mere theory or scolding of the pleader."

The case against the Fuller company was first brought Nov. 24, 1922, as reported in *Engineering News-Record*, Nov. 30, 1922, p. 948.

New Suburban Water Company for Chicago District

A water company to furnish a filtered supply from Lake Michigan to the towns just outside Chicago city limits is in the process of formation. Alvord, Burdick & Howson are the engineers. To forty officials of twenty-one towns, July 1, Messrs. Burdick & Howson explained the proposed works. An 8-ft. tunnel 3,000 ft. into Lake Michigan offshore opposite Kenilworth, a North Shore suburb, is proposed to carry water inland to a 75-m.g.d. pumping station and 50-m.g.d. filtration plant of sufficient capacity to furnish the present 40 m.g.d. maximum consumption. Within 15 years the estimated 420,000 population (it is now 223,500 for the twenty-one towns) will require 125-m.g.d. pumping capacity. A 60-in. force main diminishing to 20 in. is projected to run south from Wilmette to Riverside. Oak Park (50,000 pop.) and Cicero (63,000 pop.) are the largest prospective water takers. Oak Park and several small towns which are supplied from Chicago are exteremely short of water at present, sprinkling being restricted from 10 a.m. to 6 p.m. and no water obtainable on the second and third floors during hot days.

The cost of the proposed plant is estimated at $8,000,000 and rates at about 13c. per 1,000 gal., with an 8c. schedule promised after the first two or three years. This rate is approximately that proposed in the meter ordinance now before the Chicago City Council but laid over until next fall.

Shapker, Stuart & Co. and P. W. Chapman & Co., have undertaken the financing. A. W. Strong of Oak Park who is promoting the plan cites the success of the West St. Louis Suburban Water Co., and the Philadelphia Suburban Water Company. These corporations are the result of co-operation between municipalities to obtain water.

Buffalo Mayor Loses Suit Against Proposed Incinerator

The taxpayers' injunction sought by Mayor Schwab of Buffalo against contracts for the purchase of land in Cheektowaga at $85,000 and for the erection thereon of a garbage and refuse incinerator by the Hiler Engineering & Construction Co. for $459,000 has been ruled against by an equity judge. The mayor alleged constructive fraud and waste and also contended that the two contracts were void because they had been passed by a 3 to 2 vote of the commission council instead of a vote of at least 4 of the 5 members. The Buffalo charter was recently amended by a 3 to 2 vote of the council in order to make these contract awards possible. This was done under the home rule act which, since the Buffalo decision, has been declared invalid by the Appellate Division of the State Supreme Court, as noted on p. 77. It is expected that Mayor Schwab will appeal the case, but that a hearing cannot be had until autumn. Meanwhile Buffalo will have to continue garbage disposal by burial, the piggery having been shut down by court order some weeks ago.

Canadian Parliament Opposed to Export of Power

The proposal to secure from the Government of the Dominion of Canada the right to develop power at Carillon Falls on the Ottawa River with the privilege of exporting a large quantity of this power to the United States which has aroused so much opposition on the ground that Canada will need all this power shortly, was brought up for discussion in the Canadian Parliament on June 15. At the end of the discussion the policy of the government was defined in the following resolution, which was almost unanimously adopted by the House:

RESOLVED that in the opinion of this House the export of hydro-electric power from Canada should be permitted only on yearly license and that hereafter no license for the export of power, beyond that already granted, should be issued, except with the concurrence of the province or provinces in which it is proposed to develop such power, and of any other provinces adjacent to such power and interested therein.

Sewage Disposal Plant Opened

(*Continued from page 75*)

building and that in the filter and dryer units is the most elaborate in Wisconsin.

At a dinner given by Mr. Hatton, historical and human interest sketches were given of the dozen years work. Three of the original commissioners were present (one by the way, Conrad Niederman, 81 years old, has been a reader of *Engineering News-Record* and its predecessor, *Engineering News*, since its founding). The work of an engineer, George H. Benzenberg, first chairman, so recently dead, was referred to as monumental in organization and original laying out of program. The method of choosing Mr. Hatton by sending for him after rejecting a hundred applicants was outlined by Mr. Miller. The president of City Council, Cornelius Corcoran, said the city must continue its sanitary work and filter its water supply. Then he called on all Great Lakes cities to cease polluting the lakes, Milwaukee having shown the practical way.

W. W. DeBerard, western editor, *Engineering News-Record*, briefly spoke of the intricacy of the plant and the lack of precedent which required the highest type of design. Mr. Hatton referred to the unanimous backing he had continually received from the commission and paid his respects to his assistants, to whom he gave full credit for generating the ideas from which the designs were produced. By name he mentioned them, Will J. Sando, consulting mechanical engineer, John Arthur Wilson, consulting chemist, W. R. Copeland, chemist, D. W. Townsend, Victor H. Kadish, John H. Fowles, R. R. Lundahl, Frank Trenkamp, Ernest Pflanz, and James E. Ferebee.

A more elaborate celebration will be staged in the fall when the plant has been tuned up, sludge is available to work with and all equipment can be seen in full operation.

Civil Engineers' Board Meet at Salt Lake City

Method of Nominating Officers to be Considered — Professional Ethics Discussed

Engineering News-Record Staff Report

Several forward looking movements were initiated at the board of direction meeting of the American Society of Civil Engineers held Monday and Tuesday at Salt Lake City, of which a brief resume is given in the following: The president was authorized to appoint a committee to report to the October meeting on possible revision of the method of nominating officers of the society. Several questions of professional ethics were reviewed and resolutions were adopted, first, with respect to specific cases, and second, in the matter of advertising for competitive bidding for engineering services. This second resolution pointed out that because this latter practice was unprofessional it was not calculated to attract qualified engineers of the highest character. Ethical procedures for securing such services were outlined.

A committee of the board was appointed on "aims and activities of the society" which is to survey society activities with a view to increasing activities and usefulness to the membership and to promoting the professional interests of the society and the profession at large.

The president was authorized to appoint three representatives for the society on a sectional committee of American Engineering Standards Committee on the subject of methods of rating the water power of rivers, for which it is understood the United States Geological Survey has accepted sponsorship. After resolutions were adopted relative to the loss the society had sustained in the death of Paul H. Norcross, G. M. Braune, dean of engineering University of North Carolina was appointed director to fill the vacancy on the board for the unexpired term of Mr. Norcross. The meeting places selected for next year are as follows: Spring meeting, Kansas City, summer meeting, Seattle, annual convention in the fall, Philadelphia. Applications were approved for student chapters at Villa Nova College, Antioch College, and Vanderbilt University, and the requirements for student chapters were made more rigid and more specific. The idea of offering prizes to competitively selected members of student chapters consisting of initiation fees and first year's dues in technical societies was commended. This plan, whose initiation is credited to George C. Mason of Portland, Ore., is being adopted by a large number of the sections of the society. Seventeen members attended the board meeting.

Bill to Lower License Standards Defeated in Florida

The Malone Bill to lower the standards of admission to the practice of professional engineering in the State of Florida has been vetoed by Governor Martin.

City Home Rule in New York State Upset by Court Decision

The home rule constitutional amendment adopted by popular vote in New York State in 1923 was declared invalid by the Appellate Division of the State Supreme Court on July 6, thus reversing lower court decisions. The decision of the higher court, which was unanimous, declared that the amendment was not legally enacted, because its wording was changed by the legislature of 1922 from that used in the resolution passed by the legislature of 1920. An appeal is expected. The decision, if affirmed, affects all New York State municipalities that have acted or might act under the amendment. In New York City, it will, if affirmed, invalidate 17 bills passed jointly by the Boards of Estimate and Aldermen. These include ordinances providing for municipal ownership and operation of buses, which was the occasion for the suit, and a large number of salary increases. The hope for a reversal of the decision by the highest court of the state rests largely upon the fact that the change in language already mentioned was small, relating to legislative procedure, and had nothing whatever to do with home rule as such.

Tunnel Under Ship Channel Proposed at Detroit

The Superior Tunnel Co. which has been organized in Minnesota has petitioned for a permit to construct a tunnel under St. Louis Bay to connect Duluth and Superior, Minn. Earlier plans for this tunnel were given in *Engineering News-Record*, April 23, 1925, p. 691, at which time W. H. Tischer, commissioner of public works of Duluth, was quoted in the *Bulletin* of the Minnesota Federation of Architectural and Engineering Societies as stating that although Duluth and Superior were not able to finance the project, assurances had already been obtained that outside interests would undertake its construction.

The proposed tunnel is to be 30 ft. in diameter and is estimated to cost $4,000,000. If the franchise is granted this summer, it is expected that work will be begun in the fall.

No definite announcement has been made as to who is to be engineer for the new company, but at the present time H. H. Mitchell, c/o Commissioner of Public Works, Duluth, is consulting engineer for the project.

Flood Control Dam to Be Built at San Antonio, Tex.

A dam to control the floods in Olmos Creek is to be built by the city of San Antonio, Tex., ½ mile above the northern city limits. The dam is to be of gravity type 1,920 ft. long with a maximum height of 80 ft. It will carry a 24-ft. roadway supported by arches on the downstream side of the dam. The city intends to develop the area surrounding the detention reservoir as a park and consequently will give the dam an architectual treatment in keeping with the location.

Excessive Pressure Rise Bursts Moccasin Penstocks

In starting up a unit in the Moccasin Creek power house on the Hetch Hetchy project (under a static head of 1,316 ft.) a gate valve at the lower end of the penstock was opened without first opening the bypass to fill the pipe between the valve and the wheel. The excessive water hammer that resulted caused the rupture of two of the four penstock lines at a point about 4,000 ft. from the power house and just below the point where the lines branch from two to four pipes.

At this plant the two penstocks leading from the surge chamber, which is 6,000 ft. from the power house, branch into four lines and these four in turn branch again near the power house to serve the four double overhung wheels.

The first rupture occurred in No. 1 line, serving the unit which was being started up. The second rupture occurred in line No. 4, farthest removed from No. 1, and at a time estimated to be about 15 minutes later. Both these pipe lines are 66 in. in diameter at the point of rupture.

With the penstock arrangement described it is possible that a series of pressure waves might be built up that would gradually get out of phase enough to cause an excessive surge in one of the lines some 15 minutes after the first break.

Directed by San Francisco's city engineering department, an analysis is being made to definitely establish all facts involved. The pipe line was damaged only at the points where ruptures occurred and in each case a single new section will repair the damage. The plant is expected to be in service again within two weeks.

San Francisco Signs Contract for Sale of Hetch Hetchy Power

An ordinance authorizing the temporary distribution of power from the Moccasin Creek plant of the Hetch Hetchy project over lines of the Pacific Gas and Electric Co. was passed by the San Francisco board of supervisors and signed by the mayor on June 29. This action following a prolonged debate over price and legality accepts the power company's offer of $2,000,000 per year for the 400,000,000 kw.hrs. which is the estimated annual output of the 80,000-kw. plant. The contract is subject to termination by either party on one day's notice.

The Moccasin Creek power house has just been completed and put in operation at the lower end of the mountain division of the city's water supply project. A high tension transmission line was built by the city from the plant to Newark (about 100 miles) where connection is now being made with the power company.

Endeavor is being made to secure the assurance of the Secretary of the Interior and the attorney general's office at Washington, D. C., that the contract is not in conflict with the requirements of the Raker Act, the congressional grant under which San Francisco has developed the Hetch Hetchy water supply project.

Power Development at Grand Falls Approved by Commission

The International Joint Commission at a meeting held in Montreal on June 13 approved the application of the New Brunswick Electric Power Commission for permission to develop power at Grand Falls on the St. John River in New Brunswick. Development of power at this site comes within the jurisdiction of the International Joint Commission because, although the site itself is entirely within the Canadian border, the St. John River is international in character and the pond which it is proposed to construct will flood certain lands within the State of Maine. The present plans of the New Brunswick Commission call for an initial installation of two 25,000-hp. units and provision for a third unit of the same size. With storage reservoirs in the State of Maine and also in Quebec, the power output can be still further increased.

Recently the Provincial Legislature of New Brunswick passed a bill providing a credit of $9,000,000 for the power development at Grand Falls.

As a result of the above decision the New Brunswick Electric Power Commission is now calling for bids on the dam and power house and for a railroad to the site of the power plant.

Chicago Technical Staff Suspends Work for Half a Day

As a protest to the city council finance committee the engineering staff of Chicago quit work June 30. It was not a strike but a suspension of work which was to continue for three days without pay to bring to the finance committee a realization of the inequable treatment afforded the engineers as compared with union labor and other classes of city employees. Due notification had been given Col. A. A. Sprague, commissioner of public works, Mr. Sloan, president of the board of local improvements, and other officials. They are sympathetic to the requests of the engineers as is Mayor Dever. The engineers state a raise is not asked for but an adjustment on the basis of the buying power of the dollar in 1914 which will require $38,000 additional appropriation for the remainder of 1925. After one-half day had passed assurances from the Mayor that adjustment would be made brought all the engineers that could be located back to their positions. No men left emergency jobs such as engineers in charge of chlorine application and tunnel construction.

In briefs submitted to their superiors by Arthur Sullivan, president of the Engineering Employes' Association, representing more than 300 of the 574 in the engineering classification, tables are shown indicating that engineers' salaries for similar positions are higher in New York, Detroit, Cleveland, St. Louis and Milwaukee than in Chicago. Also it is stated that the engineers working for the following companies are better paid: Illinois Central R.R., H. M. Byllesby & Co., Holabird & Roche, Sinclair Refining Co., Chicago Bridge & Iron Works, U. S. Gypsum Co., Chicago, Burlington & Quincy R.R., Standard Oil Co., Thompson Starrett Co., and Leonard Construction Co., Compared with school teachers, construction foremen, skilled and unskilled laborers, the remuneration of the engineers shows up in the brief to disadvantage.

This novel three-day vacation was not a protest staged by underlings only but included the heads of departments such as John Ericson, city engineer, and his first assistant, Major M. B. Reynolds; C. D. Hill, chief engineer, Board of Local Improvements, Thomas G. Philfeldt, bridge engineer, Herbert Hudson, sewer maintenance engineer and Robert Knight, deputy building commissioner.

Thirty-five engineers have left city employment since Jan. 1. Turnover cost to the city is estimated at $1,000 per man. The amount asked for is about this sum. The designing division is continually on the lookout for men but cannot hold them. The Civil Service lists rarely have available men for the better paid positions.

Random Lines

Promoting Inter-professional Amity

"My grudge against engineering is solid and substantial"—C. H. Whittaker, Editor of the *Journal* of the American Institute of Architects in that *Journal* for April, 1925.

* * *

Locking the Barn Door

Russellville, Ala.,—Strict enforcement of all sections of the city building code which has been in effect for sometime but which has been allowed to remain inactive, has been ordered by Fire Chief-Inspector R. K. Elliott following destruction of the McRae hotel and the near loss of life in the midnight fire several weeks ago.

* * *

"The White Moth"

How many millions of people there must be who remember the "White Moth," the overflow from the "Purple Emperor," that made its one hundred and fifty-six miles in two hundred and twenty-one minutes every night. The "007" pulled it, the "007" that went his first night out of the roundhouse to the relief of the big Mogul, wrecked on "nothing but a shote." Kipling wrote the story nearly thirty years ago, in the period of "The Bridge Builders" and "The Ship that Found Herself" and they are all no longer just stories; they have become literature. Small wonder then that the Pennsylvania, when it decided to try a little pyschology and personify its freight trains, went to "007" for inspiration. But it does seem too bad that the "Moth" and the "Emperor" should have to come down to freights. They were, every one will remember, the distilled essence of passenger train luxury. No modern newspaper advertisement or press agent blurb can beat the last paragraph of "007" as a business puller.

A.S.M.I. Convention in October at Des Moines, Ia.

The American Society for Municipal Improvements has sent to its membership the first notice of this year's annual convention and exhibit of equipment and materials to be held in the Hotel Fort Des Moines, Des Moines, Ia., Oct. 26-30. The local committee in charge of arrangements is headed by M. L. Patzig, chairman, and includes also Carl Kastberg, vice-chairman, and George E. Hamilton, secretary; the committee's offices are at 206-11th St., Des Moines.

The convention committee points out that this year's meeting is to be held in a location more central than in past years and should, therefore, be accessible to a large number of engineers, contractors and manufacturers of equipment in the municipal field. The exhibit of equipment will be in the hotel ballroom which will serve as an entrance to the convention hall.

Charles Carroll Brown, the society's secretary, is now making up the technical program. His address is Lakeland, Fla.

Merger of Canadian Pacific and Canadian National Proposed

A special committee of the Canadian Senate has recommended the merging of the Canadian National and Canadian Pacific Railway systems for the purposes of administration and operation. The plan suggested is that both railways should be placed under the management of a board of 15 directors, 5 to be named by the C.P.R., 5 by the federal government and these 10 to choose 5 proven, capable business men to complete the board. It is further recommended that in the event of the joint management producing a surplus a dividend at the same rate as is paid to the C.P.R. be paid to the government on the capitalization placed on the government railway.

The special Senate committee has been holding an inquiry into the railway problem for two months, and evidence has been given by prominent railway experts and other business men.

Civil Service Examinations

UNITED STATES

For the following civil service examinations apply to the U. S. Civil Service Commission, Washington, D. C., or to any local office of the commission.

Assistant Chief Accountant - Engineer, Senior Accountant, Accountant—Vacancies in the U. S. Department of Agriculture for assignment to duty with the Federal Power Commission; entrance salaries for the three positions are respectively $3,800 for assistant chief accountant-engineer, $3,300 for senior accountant, and $3,000 for accountant, with possibility of promotion up to $5,000, $3,900 and $3,600 respectively. All applicants for these positions must be qualified in public utility accounting as applied to electric light and power utilities.

Receipt of applications for these positions will close July 28.

Canadians Favor Detroit Bridge

At a recent meeting in Windsor, Ontario, of those interested in the scheme to span the Detroit River with a steel bridge to cost approximately $12,000,000, it was decided to send a delegation to Ottawa to seek enabling legislation from the federal government, authorizing Essex County to guarantee bonds to the extent of $5,000,000 for an international bridge to be built by either a company or the municipalities.

Engineering Societies

Calendar

Annual Meetings

NEW ENGLAND WATER-WORKS ASSOCIATION, Boston, Mass.; Annual Convention in connection with trip on St. Lawrence River, Sept. 8-12, 1925.

AMERICAN SOCIETY OF CIVIL ENGINEERS, New York City; Fall Meeting, Montreal, Que., Canada, Oct. 14-16, 1925.

AMERICAN PUBLIC HEALTH ASSOCIATION, New York City; Annual Convention, St. Louis, Mo., Oct. 19-22, 1925.

AMERICAN SOCIETY FOR MUNICIPAL IMPROVEMENTS, Lakeland, Fla.; Annual Meeting, Des Moines, Iowa, Oct. 26-30, 1925.

The Minnesota Federation of Architectural and Engineering Societies has been invited by the Mayor of Winnipeg, Man., the local chapter of the Engineering Institute of Canada at Winnipeg, and other engineering and architectural societies to hold their summer meeting in Winnipeg some time in August. The Minnesota societies hope that the societies of North Dakota and Iowa will join them and the Canadian societies hope to be joined by societies from the neighboring provinces in order to have a representative gathering of engineers from the Northwest.

Personal Notes

J. C. BOWMAN, field engineer of the Colorado Highway Department, has resigned and has joined the engineering force of the Missouri Highway Department.

CHARLES W. STANIFORD has been appointed by the Port Raritan Survey Commission to make a physical and economic survey of the Raritan River district. The commission has been set up by the various municipalities in the vicinity of Raritan Bay and Raritan River. Mr. Staniford was for many years chief engineer of the New York Department of Docks and Ferries and for the past six years has practised as a consulting engineer specializing in terminal development. He is also consulting engineer to the Board of Commerce and Navigation of New Jersey. F. W. HERSEY has been retained by the commission as Mr. Staniford's assistant.

W. M. PETERS has been appointed assistant chief engineer of the Woods Bros. Construction Co., Lincoln, Neb., and will be in charge of the seawall construction in Harrison County, Miss., a contract for which has been let to the Woods Bros. Construction Co. Mr. Peters will make his headquarters at Gulfport, Miss. H. P. O'HAGAN has been named general superintendent on the sea-wall construction.

ROBERT DUBOIS who has been in charge of the bridge department of the Colorado Highway Department since 1919, has resigned and will accept a position with the New Jersey Highway Department.

K. B. OLSON, Birmingham, Mich., who has been general superintendent of the Willite Road Construction Co. of Michigan, Inc., of Detroit, Mich., since 1922, has resigned to enter the paving business as an individual.

CLYDE F. SMITH has resigned as sanitary engineer of the city of Long Beach, Calif., and on July 1 became resident engineer of Los Angeles sanitation district No. 1 with headquarters at Watts.

GENERAL HARRY TAYLOR, the Chief of Engineers, left July 5 for Alaska where he will inspect the work of the Alaska Road Commission, a federal agency operating under the Corps of Engineers. General Taylor also will inspect Wrangell Narrows as the Corps of Engineers has been asked to recommend the removal of obstructive rocks and shoals in that portion of the inland passage.

FRED M. RANDLETT, chief engineer of the Portland, Ore., Water Department, resigned July 1 to become Pacific Coast manager for the Robert W. Hunt Co., testing engineers, with headquaters in Portland. Mr. Randlett has been with the Portland Water Bureau since 1906, and has been chief engineer since 1917.

GEORGE M. VERITY, president of the American Rolling Mills Co., received the degree of doctor of laws from Miami University, Oxford, Ohio, June 15.

Obituary

JOHN TONER BARR, contracting engineer, Pittsburgh, Pa., died June 27 in a hospital in Pittsburgh, at 49 years of age. Mr. Barr was born in Pittsburgh and studied engineering at the University of Western Pennsylvania—now the University of Pittsburgh. He spent some years variously in railroad surveys and city railway work, in design and construction of mining and hydroelectric structures, and was at one time assistant city engineer of Salt Lake City, Utah. Since 1907 he had been contracting engineer in Pittsburgh.

From the Manufacturer's Point of View

A Point of Contact
Between Maker and User of
Construction Equipment and Materials

Safety Devices to Be Exhibited in Cleveland

"If your product is in any way related to the safety, health or welfare of the public at work, on the streets or highways or in the home, you are urged to demonstrate the product before 5,000 delegates who will attend the Fourteenth Annual Safety Congress at Cleveland, Ohio, Sept. 28-Oct. 2," reads the announcement recently sent out by the National Safety Council.

The exhibit will be held in connection with the Annual Safety Congress. Exhibit space is to be provided in the Winton Hotel.

Sales of Asphalt and Related Bitumens Increased in 1924

According to a statement issued by the Department of the Interior, based on figures compiled in the Geological Survey, asphalt and related bitumens produced in the United States in 1924 increased in both quantity and value. The sales of native asphalt and related bitumens were 570,000 short tons, valued at $3,988,000. The sales of asphalt manufactured from domestic petroleum were 1,158,000 short tons, valued at $14,306,000; from foreign petroleum, 1,920,000 tons, valued at $21,711,000.

Business Notes

L. A. SCHECK has been appointed manager of the Boston sales office of the Webster Mfg. Co., Chicago.

DEAN HILL PUMP CO., Anderson, Ind., announces the appointment of two new territorial representatives—Wagner & Wagner at El Paso, Texas, and J. Harry Burroughs, Buffalo, N. J.

SCOTT VALVE MANUFACTURING CO., Detroit, announces the appointment of H. P. Rodgers & Co., Cleveland, Ohio, as representative for its line of bronze and iron body valves.

AMERICAN CREOSOTE WORKS, New Orleans, announces the opening of an eastern sales office in New York City, in charge of Stanley H. Rose who is eastern and foreign sales manager of both the American Creosote Works, and the Savannah Creosoting Co.

LEO KRAEMER, formerly building code engineer for the National Lumber Manufacturers' Association, has been appointed field engineer of the Southern Pine Association. Mr. Kraemer's new duties will include investigation of the requirements of the various wood-using industries, study of new uses for southern pine, and studies of manufacturing and merchandising methods in the southern pine industry.

WALLACE & TIERNAN CO., Newark, N. J., has recently equipped a truck to make an educational tour of the country in the interest of sterilized water by the use of liquid chlorine. The truck contains chlorinating apparatus for demonstration purposes.

E. GWYNN ROBINSON, formerly with R. E. Brooks Co., New York City, is now associated with the Ginsberg-Penn Co., Inc., New York City, distributors of construction equipment.

AMERICAN LOCOMOTIVE CO., New York City, has received an order from the Imperial Government Railways of Japan for 6 Pacific type super-heater locomotives weighing 192,000 lb. These locomotives will be the most powerful passenger locomotives in service in Japan.

WESTINGHOUSE ELECTRIC & MFG. CO., East Pittsburgh, held its annual stockholders' meeting, June 10. F. A. Merrick, vice-president and general manager of the company, was elected to the board of directors to fill the place made vacant by the recent death of A. G. Becker. The following directors were re-elected: James D. Callery, Philadelphia Co., Pittsburgh; Paul D. Cravath, Cravath, Henderson de Gersdorff, New York; Harrison Nesbit, president, the Bank of Pittsburgh; H. P. Davis, vice-president, Westinghouse Electric & Mfg. Co. President E. M. Herr of the Westinghouse Co. forecast stable business conditions "without material variation either up or down."

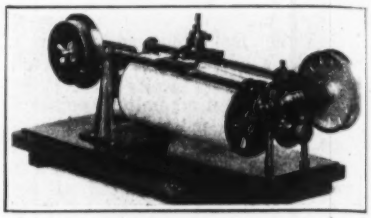
REPUBLIC FLOW METERS CO., Chicago, announces the opening of a factory branch office in Buffalo, N. Y., to be in charge of W. W. Barron, formerly of the Chicago office of the company.

Equipment and Materials

New Graphic Water Level Recorder Has Wide Range of Use

The new graphic water level recorder, manufactured by W. & L. E. Gurley, Troy, N. Y., is especially useful to organizations engaged in studying stream flow under widely varying conditions. Time scale changes are made by varying the clock or clock-winding drum; elevation scale changes are made by varying the gear ratio or the diameter of the sprocket wheel. The record sheet is 12 in. long; record of stage is made around the cylinder while time scale is parallel to its axis. By selecting a gear ratio that takes care of the normal rise and fall within one revolution, a large scale record is obtained.

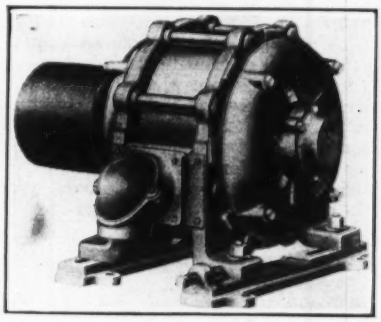
The machine can be adjusted easily and the record sheet changed without altering the setting. The clock is of the weight-driven marine type enclosed in a dust and waterproof case. Two clocks are available, one to give a



weekly time scale and the other to give a daily time scale. The recorder is built of non-corrosive materials; the float and sprocket wheels are of white metal, the tape of Monel metal, pencil carriage, gears and gear holder of bronze, the support rods of nickel alloy, the cylinder of brass and the shafting of rustless steel. The makers believe that the float method is the best of the various ones used for translating the movement of the water level to the record sheet. A 10-in. float is standard equipment since the sensitiveness of its movement is greater than that of a smaller float.

Magnetic Self-Starting Motor

The U. S. Electrical Mfg. Co., Los Angeles, has developed an automatic self-starting squirrel-cage motor without any moving parts in the starting



mechanism. When starting is accomplished by manual switches the operator must first throw the switch into starting position, and finally into running position. To eliminate the human element mechanical starters are used which contain a large number of moving parts. This new motor is said to accomplish magnetically what has heretofore been done mechanically.

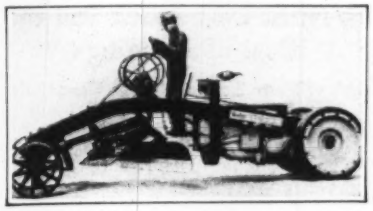
The motor can be installed directly across the line without the use of current reducing starters, which are said to cost usually about 50 per cent as much as the motor itself. The current, when first turned on, is carried in part of the cage only until the motor attains its speed, at which time the complete squirrel cage takes the load by magnetic action. It is claimed that the

motor will accelerate full load in 20 per cent less time than required by the old type motor and compensator. The motor has a high starting torque, and its efficiency and power factor are normal for squirrel-cage motors. These motors are available in sizes ranging from 7½ to 50 hp.

One-Man Fordson Grader

The new model one-man grader of the Wehr Co., Milwaukee, embodies several new features. The steel head casting has been made 80 lb. heavier and the brackets which support the lifting worms have been made much stronger. Height and wheelbase have been slightly increased. The blade can be lifted 12 in. off the ground and turned to any desired angle without interference with either the front end of the tractor or the radius rod yoke.

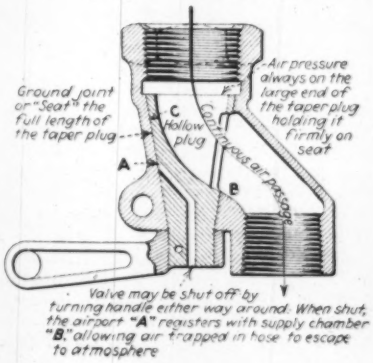
The Fordson power plant is supported at the front end by a large yoke which extends above the 8 in. channel frame and is utilized as cross-member bracing. In addition, there are eight other cross-members tying the 8 in. channels together. Provision is made for attaching the scarifier directly to the steel circle by bosses which are cast as an integral part of the circle. Improvements that have been made for the comfort of the operator include softer spring support for the platform, adjustable seat, and larger diameter lifting wheels.



Valves for Compressed Air Lines

An air valve that is said to overcome much of the trouble experienced in the economical distribution of compressed air in railroad and industrial plants has been designed by the Cleveland Pneumatic Tool Co., Cleveland, Ohio. A feature of the valve is the elimination of packing, springs, disks, washers, stems, etc., the air itself under pressure acting as the seating agent holding the valve plug on its seat. The valve has but three parts—body, plug, and handle. A leak port is provided to bleed the air from the hose or pipe when the valve is closed. This is a safeguard against accident when disconnecting hose or pipe from the valve, when it frequently happens that a burst of air is forced into the operator's eyes, carrying with it scale from the pipe, often with serious results.

The company announces that every shop condition has been met by different styles and shapes of valves to suit the many different connections required on pipe lines, some of which are very complex, requiring different shaped valves to fit into odd corners in shop lines, locomotive pits and car shop manifolds.


Ground joint or "Seat" the full length of the taper plug
C
Hollow plug
Air pressure always on the large end of the taper plug holding it firmly on seat
A
B
Various air passages
Valve may be shut off by turning handle either way around. When shut, the airport "A" registers with supply chamber "B," allowing air trapped in hose to escape to atmosphere

Pre-Mixed Materials Are Placed by New Mortar Gun

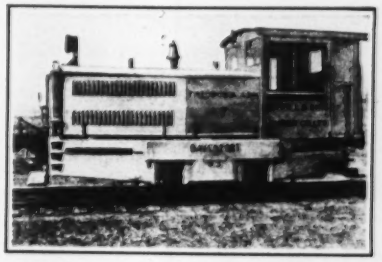
A new mortar gun that uses compressed air to discharge pre-mixed mortar upon various backgrounds has been designed by Albert Oliver & Son, Inc., New York, and is being marketed by the Chicago Pneumatic Tool Co. The gun is essentially a hopper shaped receptacle terminating in a horizontal orifice at its lower end. The mortar in flowing toward the orifice falls into a jet of compressed air entering from the rear at the bottom of the hopper and is discharged at high velocity. The air pressure at which the gun operates most satisfactorily is about 40 lb.

The equipment is especially useful for applying exterior stucco, plaster and waterproofing, for building 2 to 4-in. curtain walls, for encasing structural steel and for similar applications. The mortar gun is operated by one man, its normal loaded weight being 18 lb.; loaded flush to the top it weighs 32 lb. and the empty hopper weighs 7 lb. It is fast in operation, 40 sq.yd. of stucco being applied in about 7 min. at a recent test.

Two types of guns are being made, the "plaster gun" and the "wall-building gun." The main difference lies in the larger amount of mortar that can be discharged by the wall-building gun in a given time. Furthermore, the mortar used with this type requires much less water than is the case with that used in the plaster gun. Mortar placed with either gun can be dressed sooner after application than can hand placed mortar. Both guns are claimed to give 25 to 30 per cent more spread than can be obtained by hand methods. The main feature of the guns is their use of a pre-mixed mortar which eliminates any possibility for voids or sand pockets in the structure.

20-Ton Gasoline Locomotive Has Individual Wheel Drive

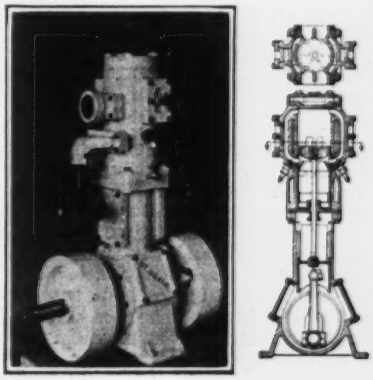
Enclosure of all working parts and roller chain transmission providing individual drive on all four wheels are features of the new tapered-hood 20-ton gasoline locomotive developed by the Davenport Locomotive Works, Davenport, Ia. The axles are of large diameter and ride in Timken roller bearings which take side thrust as well as the weight of the machine. It is claimed that this individual wheel drive gives better tracking qualities than when an axle drives two wheels. The locomotive is equipped with a six-cylinder Climax engine, self-starter, Westinghouse air brakes, and electric lighting for headlights and cab.



Valveless Uni-Flow Engines

An engine operating on either gasoline or kerosene that is claimed to have greater simplicity, higher economy, less weight and more power than the present types of gasoline engines, is being developed by Palmer St. Clair, Jr., Roanoke, Va. It delivers a power stroke every revolution, operates equally well in either direction, utilizes uniflow passage of working charge through the cylinder, and has an action similar to that of a steam engine. The only moving parts are the piston assembly, connecting rod and crankshaft. The cycle of operation is as follows:

When the piston moves upward, drawing in the fresh charge in the lower part of the cylinder on opening



of the intake port by the piston skirt, the previous charge is being compressed in the two explosion chambers or passages, which are closed at the upper end of the stroke by the piston when the explosion occurs; after explosion or detonation, the piston on its downward stroke opens the upper ports from the explosion chamber admitting the high pressure gases smoothly and in an accelerated manner, thus forcing the piston down to the bottom of the stroke; at the same time, the fresh charge in the lower part of the cylinder below the piston is being slightly compressed, and while the upper expanded gases are being exhausted at the bottom of the stroke, the fresh charge below is being forced through the ports in the piston and cylinder walls into the two opposite explosion chambers or passages.

It is claimed that increased fuel economy is obtained by localizing the charging and by utilizing internal preheating and uniflow passage of gases. In addition to its adaptability for general gasoline work, this engine equipment is said to have possibilities for use in the automotive field. Because its operating characteristics are similar to those of the steam engine, it is claimed that this uniflow engine is suitable for direct connection in automobiles, resulting in the elimination of the transmission and reverse gears. It is adapted to any number of cylinders, either vertical, horizontal or "V" type, in line or opposed.

Publications from the Construction Industry

Cast-Iron Pipe Fittings — GRINNELL CO., Providence, R. I., announces in a recently published catalog a new design of water-works socket fitting which has a reduced size and weight over the old style fittings and at the same time lessens friction losses. Tests established the fact that a medium radius would give less resistance to flow than a larger radius and the fittings are designed on this basis. The value of this type of fitting is especially pronounced in making connections in limited spaces. Tables and line drawings give complete data for ordering purposes.

Drills — SULLIVAN MACHINERY CO., Chicago, has recently made available four new bulletins on Rotator hammer drills, air feed stoping drills, water hammer drills, and hammer drills for line drilling.

Air Compressors — SCHRAMM, INC., West Chester, Pa., describes in a new air compressor catalog, C-25-A, its complete line of compressor equipment. This includes both engine and belt drive, portable and stationary compressors and truck and tractor combination mountings. Numerous examples and illustrations are given of the use of Schramm compressor outfits on various types of construction work.

Business Side of Construction

FACTS AND EVENTS THAT AFFECT COST AND VOLUME

E. N.-R. Cost Index Booklet

For the convenience of our readers who use the Engineering News-Record Construction Cost Index Number we propose to prepare a booklet explaining its method of computation and comparing it with indexes that apply to specific types of construction and specific sections of the country.

It is desired to include in this booklet descriptions of how certain of our readers are using the E. N.-R. Cost Index and what their experience with it has been. All readers cooperating with us in this manner will receive a copy free of charge just as soon as the booklet is off the press. Write to

Construction News Editor,
Engineering News-Record,
Tenth Ave. at 36th St.,
New York.

This Week's Contracts—Week Ago—Same Week Last Year

The money value of contracts reported in the present issue of *Engineering News-Record* is here compared with the figures for corresponding weeks.

Minimum costs observed are: $15,000 for water works and excavations, $25,000 for other public works, $40,000 for industrial and $150,000 for commercial buildings.

MONEY VALUE OF CONTRACTS LET—ENTIRE U. S.

Week Ending	Public Work	Private Work	Total Contracts
Jul. 9, 1925	**$12,346,000**	**$7,817,000**	**$20,163,000**
July 2, 1925	21,237,000	24,542,000	45,779,000
July 10, 1924	18,613,000	12,054,000	30,667,000
Heaviest Week			
1924, May 8	26,370,000	38,829,000	65,199,000
1925, Apr. 2	43,603,000	27,633,000	71,236,000
Jan. 1 to Date			
1925	533,927,000	676,513,000	1,212,440,000
1924	520,356,000	559,352,000	1,079,708,000

Present Construction Volume Predicted to Continue

The volume of construction for the first six months of 1925 is 11 per cent greater than the same figure for 1924.

The accompanying tabulation shows the condition of the various classes of construction for the first six months as published by *Engineering News-Record:*

	First Half of 1925	Change Over 1924
Waterworks	$32,527,000	— 6.3
Sewers	34,534,000	+ 8.2
Bridges	34,821,000	— 2.7
Excavation, etc	6,045,000	—47.7
Streets and roads	224,117,000	— 0.5
Industrial buildings	88,835,000	—15.8
Commercial buildings	601,835,000	+25.0
Federal Government	19,661,000	+ 2.0
Unclassified	102,928,000	+25.0
Total	1,144,498,000	+11.4

Business Briefs

Call money quoted at 4 per cent, July 6; year ago, 2 per cent.

Time loans: short terms, 3¾@4 per cent; longer periods, 4@4¼ per cent.

Commercial paper: best names, 4 per cent; other names, 4¼ per cent.

FOREIGN EXCHANGE (DEMAND)

	Par	This Week	Last Week	Year Ago
Sterling	$4.86⅔	$4.85⅛	$4.85⅛	$4.33
Franc	.193	.0471½	.0452	.0515
Lira	.193	.0372½	.0355½	.0425
Mark	.238	.238	.238	
Florin	.402	.4007½	.4004	.3771
Peseta	.193	.1454½	.1452	.1324
Krona	.268	.268	.2678½	.2655

E. N.-R. Cost Index and the Cost of Buildings

Cost of Four Types in Nine Geographic Sections Compared with General Construction Cost

The accompanying charts compare costs of four standard types of buildings with general construction cost for the entire country. The four structures are frame, brick (wood framing), brick (steel framing) and reinforced concrete. Index numbers of actual costs on these buildings, as determined by repricing, were compiled by the American Appraisal Company of Milwaukee and show trends over a period of years in nine geographic divisions of the United States.

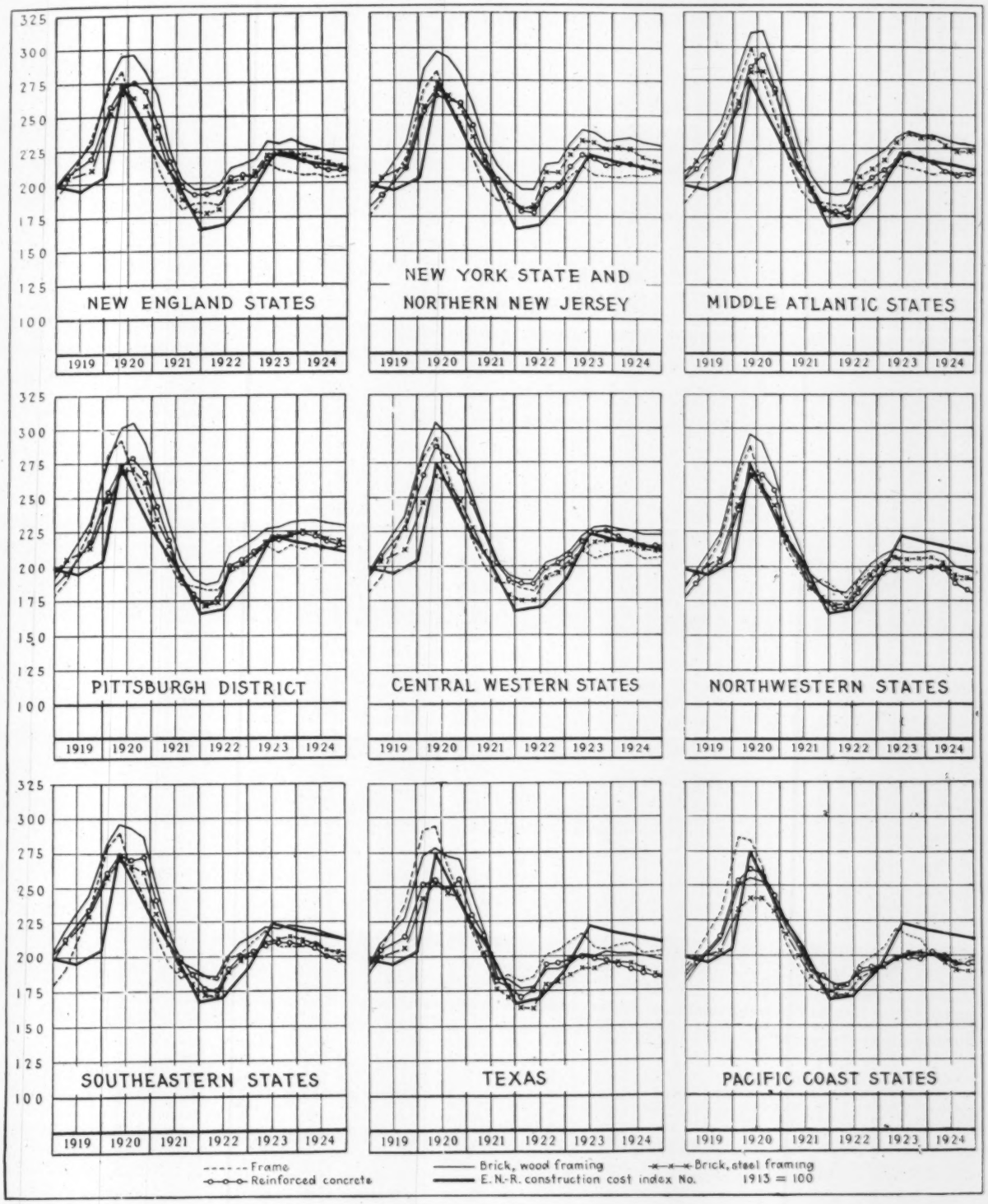
Construction costs for the entire country are represented by the *Engineering News-Record* Construction Cost Index Number. This Number is based on four elements of construction cost that are nation-wide in scope, namely, steel, lumber, cement and labor. Price fluctuations in other materials are more or less local in nature and are, therefore, not included in the *E. N.-R.* Index. All numbers are based on 1913 as 100.

It is apparent from the charts that building costs as applied to the types mentioned, in the Northwest, the Pacific Coast states and Texas, during the 1919 to 1920 inflationary period, did not contribute as strongly to the rise in general construction cost as did costs of similar buildings in other parts of the country. These buildings in the sections designated dropped considerably below the cost level for the nation during 1923 and 1924.

In Texas and the Pacific Coast states frame buildings cost more than other types. In most sections of the United States, brick buildings with wood framing are more expensive than other types, while frame construction is cheapest. This has held true practically since the beginning of 1919.

Brick buildings, with steel framing, however, are in a class with reinforced-concrete construction and the two together in all parts of the country seem to occupy a price position about mid-

Comparison of Building Costs, Four Different Types in Nine Sections of the Country (American Appraisal Co. Index No.), With General Costs For Entire Country, (E. N.-R. Construction Cost Index No.)



way between those of frame buildings and of brick (wood frame) construction.

These curves show uniformity of building costs throughout the country. They also show that all forms of construction in all parts of the nation rose simultaneously to the peak of 1920 and struck the extreme low point for the six-year period in the early part of 1922. Costs have flattened out, since the beginning of 1923, on a level not quite halfway between the 1920 peak and the low point of 1922. The tendency continues to be downward.

Weekly Construction Market

THE reports from the brick industry are vitalizing and hopeful. All indications are that 1925 will be a new peak year for this industry in making records for brick made and sold.

The west coast lumbermen show that new business was only 4 per cent below production while shipments were 12½ per cent above the new business.

Chicago shows activity in all sections in the construction industry.

Lumber stocks in the Twin City yards, wholesale and retail, are reported a little above normal, owing to the demand made during the past thirty days.

St. Louis is experiencing an unprecedented building program. The first six months of this year gives an increase of $13,000,000 over the same period in 1924.

Price changes are few. The linseed oil decline is seasonal and is only reflecting an adjustment in anticipation of the new flax crop.

Stock conditions in the various cities reporting regularly to *Engineering News-Record* are good.

All indications are that the activity shown by the construction in the past six months will hold. The prospect is that the volume of construction now reached will continue during the next few months. This does not mean that the volume of new building will be maintained in all localities. Another assurance of the continuation of the building volume is that money for the construction industry is plentiful.

Financial concerns show that existing conditions are favorable—the month of June showed fewer failures than any month of this year and its liabilities, except for March, are less than any one month since November.

	New York	Atlanta	Dallas	Chicago	Minneapolis	Denver	San Francisco	Seattle	Montreal
Steel Products									
Structural shapes, 100 lb	$3.34	$3.90	$4.00	$3.10	$3.35	$3.07½	$3.30	$3.35	$4.25
Structural rivets, 100 lb	4.50	4.45	+4.78	3.50	3.75	4.65	5.00	3.75	6.00
Reinforcing bars, ¾ in. up, 100 lb	3.24	3.40	—2.80	3.00	3.25	3.62½	3.35	3.25	2.30
Steel pipe, black, 3½ to 6 in. lap, discount	48%	53.2%	45%	+59½%	54.25%	36%	39.2@51%	50%	59.49
Cast-iron pipe, 6 in. and over, ton	50.60@51.60	54.00	54.00	+48.20@50.20	53.00	62.00	52.00	53.00	55.00
Concreting Material									
Cement without bags, bbl	2.50@2.60	2.40	2.05	+2.30@2.50	2.42	2.84	2.52	2.65	1.80
Gravel, ¾ in., cu.yd	1.75	1.90	2.38	—2.55	1.65	1.90	2.15	1.50	1.25
Sand, cu.yd	1.00	1.40	2.00	—2.55	1.25	1.00	1.50	1.50	1.25
Crushed stone, ¾ in., cu.yd	1.85	2.00	2.83	—2.50	1.75	2.50	2.15	3.00	1.90
Miscellaneous									
Pine, 3x12 to 12x12, 20 ft. and under, M.ft	59.00	34.00	+58.50	45.00@55.00	38.75	36.25	27.00	23.00	60.00
Lime, finishing, hydrated, ton	18.20	22.50	—19.00	20.00	25.50	24.00	22.00	24.00	21.00
Lime, common, lump, per bbl	2.50@2.75	1.45	1.85	1.35	1.35	2.70	1.60	2.80	9.50
Common brick, delivered, 1,000	19@20	10.50	—11.60	12.00	13.50	12.00	15.00	15.00	17.50
Hollow building tile, 4x12x12, per block	Not used	.0888	.10	.0888	.....	.085	.....	.10	.12
Hollow partition tile 4x12x12, per block	1162	.0888	.10	.0888	07	.085	.108	.10	.10
Linseed oil, raw, 5 bbl. lots, gal	—1.01	—1.10	—1.25	.99	—1.06	1.31	1.14	1.12	1.25
Common Labor									
Common labor, union, hour	.75	.30	.....	.87½	.....	.50@.55	.55	.62½	.....
Common labor, non-union, hour	.....	.25	.30@.50	.75	.50@.55	.35@.50	.50	.50	.25@.35

Explanation of Prices—Prices are to contractors in carload lots unless other quantities are specified. Increases or decreases from previous quotations are indicated by + or — signs. For steel pipe, the prevailing discount from list price is given; 45-5% means a discount of 45 and 5 per cent.

New York quotations delivered, except sand, gravel and crushed stone, alongside dock; common lump lime, in 280-lb. bbl. net, and hydrated lime f.o.b. cars; tile "on trucks"; linseed oil and cast-iron pipe f.o.b. Labor—Concrete laborers' rate, 93⅞c.; building laborers, 75c.; excavating laborers, 50c. per hr.

Chicago quotes hydrated lime in 50-lb. bags; common lump lime per 180-lb. net. Lumber, sand, gravel and stone delivered on job.

Minneapolis quotes on fir instead of pine. Brick, sand and hollow tile delivered. Cement on cars. Gravel and crushed stone quoted at pit. We quote on brown lime per 180-lb. net; white is $1.70 for Kelly Island and $1.60 for Sheboygan. Common labor not organized.

THIS limited price list is published weekly for the purpose of giving current prices on the principal construction materials, and of noting important price changes on the less important materials. Moreover, only the chief cities are quoted.

Valuable suggestions on costs of work can be had by noting actual biddings as reported in our Construction News section.

The first issue of each month carries complete quotations for all construction materials and for the important cities. The last complete list will be found in the issue of June 4, the next on July 2.

Denver quotes on fir instead of pine. Cement "on tracks"; gravel and sand at pit; stone on cars; lime, brick, hollow tile and lumber on job. Tile price is at warehouse. Linseed oil, delivered in wooden bbl. Common lump lime per 180-lb. net.

Atlanta quotes sand, stone and gravel per ton instead of cu.yd. Common lump lime per 180-lb. net.

Dallas quotes lime per 180-lb. bbl. Steel, cement, cast-iron pipe and crushed stone f.o.b. cars, other materials delivered.

San Francisco quotes on Heath tile, size 5½ x 8 x 11½. Prices are all f.o.b. warehouses except C. I. pipe, which is mill price plus freight to railway depot at any terminal. Common lump lime per 180-lb. net. Lumber prices are to dealers in yards at San Francisco, for No. 1 fir, common.

Seattle quotes on Douglas fir (delivered) instead of pine. Lump finishing lime per 180-lb. net. Brick and hollow building tile delivered. Hydrated lime in paper sacks. Sand and gravel at bunkers.

Montreal quotes on pine lumber. Sand, stone, gravel and lump lime per ton. Stone and tile are delivered; sand, gravel, lime and cement on siding; brick f.o.b. plant; steel and pipe at warehouse. Hollow tile per ft. Cement price is in Canadian funds (the Canadian dollar stands at par). Bag charge is 80c. per bbl. Discount of 10c. per bbl for payment within 20 days from date of shipment. Steel pipe per 100 ft. net; 3½-in., $59.49.

Lumber—the first twenty-six weeks of 1925 show an increase over the same period of 1924 in production, shipments and new business.

Brick—1925 is predicted to be a peak year for this industry.

Cement—stocks sufficient to meet the present volume of construction.

On July 1, 1925

E. N.-R. Construction Cost Index Number 204.60

E. N.-R. Construction Volume Index Number 214

For Explanation and Details of Indexes Since 1913 See the First Issue of Every Month